Ontario Department of Education

Science Laboratories

for Secondary Schools

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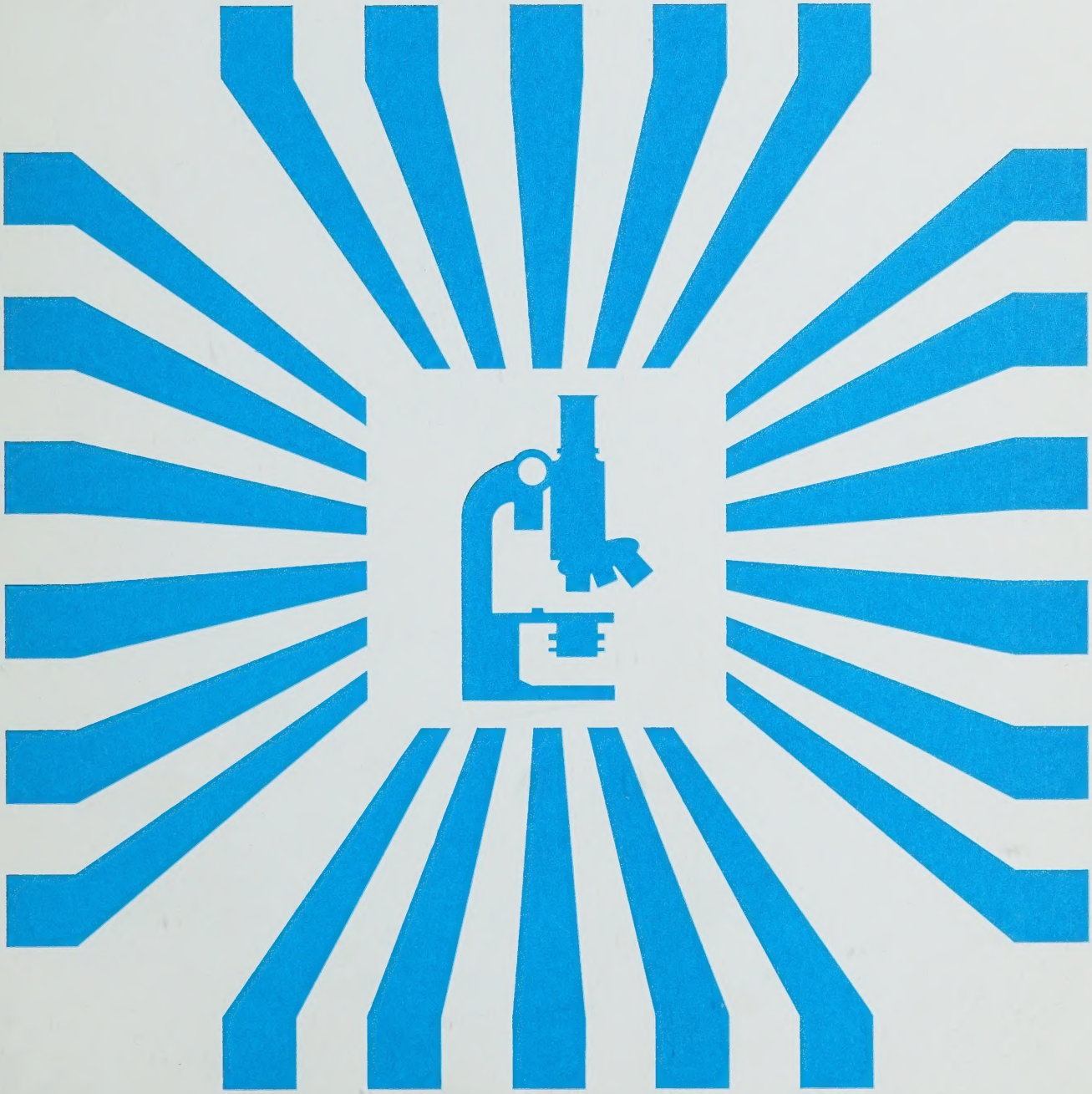

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Science Laboratories for Secondary Schools

Prepared by
Ontario Department of Education
School Planning and Building Research Section

In conjunction with
The Department of Education's
Science Committee

January 1968

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1. Preface

This presentation of suggested layouts and specifications for science laboratories has been prepared by a committee of experienced teachers and officials of the Department of Education in co-operation with the School Planning and Building Research Section. The material is designed and arranged to be of service to school boards, architects, teachers and administrators who are planning new schools or making renovations to existing structures. The recommendations include many of the facilities which have been observed in schools throughout the province and which have been found through experience to have considerable value.

Science courses are composed of a series of laboratory activities from which the concepts of science evolve. The discussion follows the laboratory activity and involves reflection on the scientific significance of what is observed. This includes explanations, applications and the development of theories.

The concepts and phraseology of science are meaningless to most students unless they are closely related to observations of phenomena observed in controlled personal experiences.

Through explanation in the laboratory, the student becomes familiar with the scientific method and with the procedures and techniques of the scientist. He learns to appreciate and enjoy problems encountered in the laboratory and ultimately learns to appreciate the overall framework of science, without which science must remain a meaningless series of disconnected parts. The success of science courses depends entirely on the nature of the laboratory work in which the student participates. The design of the laboratory and the facilities available play a dominant role in the development of effective science programs. Three basic types of laboratories are described:

a) the conventional laboratory with a work table for every two students;

b) the perimeter laboratory with areas for experimentation around two sides and one end and with desks or tables in the centre;

c) the combination laboratory with an area suitable for class discussion at one end and an area for experimentation at the other.

Other designs are variations, usually slight, of one of the three types.

Effective science programs are centred around student activities in which extensive laboratory investigations form the basis of discussion. Increased emphasis on experiment centred programs is anticipated. This approach requires, for large composite schools, one laboratory for each 200 of the school population. These laboratories should be designed to provide:

1. maximum flexibility to permit various methods of operation which may be adjusted to the personal preference of the teachers and to meet the needs of changes in organization, curricula and methods;
2. arrangement of furniture allowing easy movement of students and teachers;
3. accommodation for effective instruction of different science courses, e.g. biology and general science;
4. space where equipment and apparatus may remain assembled for several days;
5. storage facilities which may be organized by the teacher so that the time and effort required to prepare for student experimentation are reduced to a minimum;
6. areas where students may record and organize observations, study demonstrations, participate in discussion and use reference materials;
7. facilities for storage and use of visual aids including films, film strips and the following types of projectors: overhead, opaque, micro, slide, single concept or loop;
8. black-out facilities which are essential for the use of visual aids;
9. a display cupboard;
10. adequate ventilation;
11. two doors from laboratory to corridor;
12. one door from preparation room to corridor;
13. safety features;
14. area for reference books, periodicals, etc.;
15. cleaning facilities including soap dispensers and towel racks;
16. conduits for TV cable.

Area

Laboratories with 15 work stations, one for each two students, vary from 980 to 1,200 sq. ft.

For preparation rooms shared by two laboratories, an area of 390 to 450 sq. ft. is suitable. Where a preparation room serves only one laboratory, 275 to 300 sq. ft. is sufficient.

Floor

Floor coverings must be of a material resistant to chemicals and also easy to maintain. Vinyl asbestos tile is suitable; linoleum is not satisfactory.

Walls

Wall finishes, particularly in chemistry laboratories, should be of hard, washable materials such as epoxy or enamel paint. Where concrete block is used for partitions, a filler should be used to give a relatively smooth surface before application of the paint. Prefabricated partitions are also suitable for laboratories and may in many cases be preferable.

Ceiling

For acoustic purposes a suspended ceiling should be installed in all laboratories and it is suggested that a T–bar suspension system with acoustic lay-in panels be used. Care should be taken to ensure that the ceiling system complies with the fire rating for the building.

Lighting

Standards of lighting in science rooms should conform with recommended levels outlined in the National Building Code. 70 footcandles at desk tops and chalkboards is satisfactory.

Fluorescent tubes should be 'warm white', and fixtures should have glass or acrylic lenses for diffusion of the light. Ballasts must be of the commercial type.

Service Panel

A service panel with controls for all services such as gas, water, electricity and compressed air should be in a location convenient to the instructor. To indicate if all services are on or off, a pilot light should be

placed in the corridor adjacent to the door to the laboratory.

Ventilation
The requirements for ventilation of science rooms other than chemistry laboratories and associated preparation rooms should be in accordance with the National Building Code and the by-laws of the locality in which the school is situated. Additional ventilation required in chemistry laboratories is described in the section devoted to these rooms. The exhaust system from students' desks, work counters, acid storage cupboards etc., in chemistry rooms must be separate from the room ventilation system and be exhausted above roof level.

Chalkboard
Chalkboards will be required at both the front and the side walls of all laboratories, as indicated in the drawings. The use of sliding chalkboards is often an advantage; the magnetic type of board may also be considered.

Chart Rails
Chart rails are required above all chalkboards.

Tackboard and Bulletin Board
These should be located as shown in the drawings.

Projection Screen
There should be a built-in, adjustable projection screen in each laboratory.

Storage, Work Counters, Desks
1. Requirements for storage and work counters:
a) counter tops resistant to reagents, with a 2 in. overhang;
b) height of 36 in.;
c) storage depth of 16 in. minimum
(See Drawing 17);
d) adjustable shelving with a maximum length of 36 in.;
e) supports, for shelving trays and/or tote boxes
(See Drawing 17);
f) sliding doors to cupboards;
g) electrical AC outlets at intervals of 6 ft.

2. Wall-hung cupboards should have:
a) adjustable shelves with a maximum length of 36 in.;
b) sliding doors.
c) storage for 15 triple beam balances.

3. Requirements for student work desks and counters:
a) 15 work stations, each for two students, 60 in. in length, 36 in. in height in perimeter laboratories. Two students work at each station. No stools are needed. Work desks with a height of 32 in. to 36 in. and a minimum length of 48 in. are required. Two students work at each desk. Stools which will slide under desks are needed;
b) work tops of materials such as epoxy, asbestos and cement which are resistant to reagents;
c) storage for hardware, glassware, test tube rack, retort stand and tote box, if these are used. A book shelf is required in work desks only;
d) ledges under table to hold heat resistant boards, e.g. asbestos;
e) services at each station
–combination cold water and gas outlet;
–electrical 110 volt AC outlet;
–sink with cover, level with work top;
f) additional requirements for individual subjects.

4. Demonstration desk should have:
a) cupboards with adjustable shelves;
b) drawer section;
c) services
–2 gas outlets;
–2 electrical 110 volt AC outlets;
–sink with hot and cold water, and cover, level with work top;
d) additional requirements described in sections for biology, chemistry and physics.

Requirements in Preparation Rooms:
a) work counter with storage space underneath;
b) wall-hung cupboards;
c) drawers for small parts such as rubber stoppers, etc.
d) storage for charts;
e) solution rack and vertical storage units for long glassware, such as shown in Drawing 5;
f) sturdy shelf, 10 to 12 in. wide, about 18 in. above sink;
g) fireproof cabinet with lock (optional);
h) teacher's desk with 110 volt AC electrical outlet;
i) work area for small groups of students (optional);
j) space for trolleys along one wall;
k) black-out arrangements for use of visual aid material;
l) services
–sink and cover, hot and cold water, and large drain-board, preferably stainless steel;
–110 volt AC outlets in work counter at 6 in. intervals;
–2 gas outlets;
m) doorway to corridor as well as to laboratories;
n) additional requirements in sections on biology, chemistry and physics.

Chemistry Laboratory

Laboratories

There are three types of laboratory for chemistry, as shown in Drawings 1, 2, 3, 4, 5 and 17.

1. Requirements for conventional laboratory as shown in Drawing No. 1, Floor Plan C1:

a) 15 student work desks, each 54 in. x 24 in., one for each two students, are required. Details are shown in drawings.

b) Storage counters provide space for drying ovens, balances, compressed air jets and assembled equipment.

c) All equipment used by students can be stored in cupboards under the storage counters. Storage may be in the form of tote boxes or tote trays and adjustable shelving.

d) Services must include water, gas, compressed air, sinks and electricity 110 AC.

e) The demonstration desk will vary in size with individual preference but should not be less than 10 ft. long by 30 in. wide. It should contain a sink, a gas outlet, water, compressed air, two outlets for electricity 110 AC and one or two exhaust outlets. The desk should also contain storage for equipment required by the teacher during demonstration periods. A trolley on which material can be prepared and wheeled to the demonstration desk is also useful and space should be left for this when planning the layout of this area.

2. Requirements for Perimeter Laboratory as shown in Drawing No. 2:

a) This room may be used for instruction in any subject without the inconvenience of 'tinkering' with taps and equipment by students. The area of chalkboards provided is adequate for any subject.

b) The students face towards the centre of the room when doing laboratory work. This arrangement permits the teacher to observe readily the work of all groups from any location in the centre area.

c) Adequate storage space is provided for all types of equipment in the counter area and in the sections in the work benches between the services. Both tote trays and adjustable shelves are required with access to the storage from the centre of the room.

Requirements for alternative layout of perimeter laboratory as shown in C.2. Drawing No. 2:

a) Moveable tables, 24 in. wide and 48 to 54 in. long, shown in Drawing 16, serve the same purpose as the combination desks. But they may also be used for experimentation.

b) When the class is larger than usual or when the work counters are being used for assembled equipment, the tables may be moved so that one end of each is close to the services in the counters. All services are available at the tables and assembled equipment need not be disturbed.

c) The ease with which this room can be arranged to serve the needs of groups of varying size for both discussion and experimentation adds to its versatility.

d) Counters along the walls are omitted in order to provide room for the moveable tables.

3. Requirements for Combination Laboratory as shown in Drawing No. 3:

a) This type of laboratory, with the area for experimentation separate from the area used for discussion, is preferred by some teachers.

b) Supervision is not as convenient as in the perimeter laboratory and there may be some congestion in the area for experimentation.

c) The combination laboratory has many of the advantages of the conventional and perimeter laboratories including storage facilities.

Special Features of Chemistry Laboratories

1. Storage and Distribution

Requirements in the laboratory:

a) Equipment and chemicals must be stored in cupboards adjacent to students' work areas.

b) Basic equipment, used, frequently should be kept in students' work desks.

c) Class sets of special equipment (e.g. 15 gas generators) should be stored in cupboards, trays or other convenient locations.
d) Storage space is required for class sets of 4 oz. plastic dropping bottles for each solution. A set consists of 15–18 bottles.
e) 15 5 oz. bottles for each solid chemical frequently used by students must be stored.
f) 15 8 oz. (250 ml.) reagent bottles for acids and other solutions in trays in cupboards require storage space.
g) Monopan balances, if required, should be permanently located on balance pads and have electrical outlets adjacent.
Note: Fuming or volatile liquids must be stored in a vented cupboard.

a) Chemistry courses will require increased use of solutions of specific concentration. The preparation of these solutions is time consuming. A solution rack will enable teachers to prepare and store quantities sufficient for a year or more. The location of the rack is indicated in the preparation room of Drawing No. 1 and sketched in Drawing No. 5.
b) Storage space for 4 to 5 gallon containers of liquids such as distilled water, lime water and sodium hydroxide solution is provided on the wide shelf above the sink as shown in Drawing No. 5, elevation A.
c) A distribution unit, mounted on the wall or on a shelf, is required. The containers are placed below as shown in Drawing No. 5, elevation A. A unit producing one gallon per hour consumes about 2 K.W. and will also require a water supply and drain as well as an AC outlet.
d) Acid storage in Drawing No. 1, shows two connected cupboards one in the laboratory for trays, the other in the preparation room for large stock bottles of acids and fuming reagents. One exhaust fan ventilates both cupboards directly to atmosphere.
e) Combustible chemicals should be stored in a fireproof cabinet fitted with a lock.

2. Ventilation
The importance of exhaust systems in the maintenance of both the health of students and an acceptable, pleasant atmosphere for learning has not been generally recognized. Several gases used in experimentation in schools are lethal, even in extremely small quantities.

The Industrial Safety Branch of the Ontario Department of Labour has supplied the following information:
Sulphur dioxide–threshold limit 5 parts per million
Chlorine–threshold limit 1 part per million
Bromine–threshold limit 0.1 part per million
Hydrogen sulphide–threshold limit 10 parts per million
Carbon tetrachloride–threshold limit 10 parts per million
Methanol (wood alcohol)–threshold limit 200 parts per million

If the construction of laboratories does not include proper facilities designed to guard against hazards to health, it is impossible for others (teachers) to provide adequate preventative measures. It is strongly recommended that two separate ventilation systems be installed in laboratories, one a system of exhausts from the students' benches, the other a room exhaust.

Bench Exhausts
Bench exhausts systems, which exist in many schools and which are no longer in use, offer mute evidence of the inadequacy of the specifications used in construction. Careful study by specialists in teaching, ventilation and safety has resulted in the following specifications:
a) air flow requirements
–100 CFM per outlet (50 feet per minute at opening of hood);
–two speed fan.
b) hood specifications
–shape and position shown in Drawing Nos. 4 and 5;
–opening of 2 sq. ft. maximum;

Note: Collection bottles rest inside the opening.
–stack in storage
–fire-resistant clear plastic is preferred.
c) outlet specifications
–diameter of 4 in. minimum for convenience in cleaning and low noise level;
–cover level with desk top;
–one should be at each work station, two on demonstration desk and two in preparation room.

Room Exhaust System
For chemistry laboratories and preparation rooms, an exhaust system with two-speed fans is necessary. The lower fan speed should be based on 1¼ CFM per square foot of floor area of the room, for normal ventilation; the high speed, for flushing the room of gases as required, 3 CFM per square foot of floor area.

3. Safety Features
Fire, burns from corrosive chemicals, inhalation of toxic gases are a source of danger in chemistry laboratories. To minimize any resultant injury, the following items should be located in convenient, easily accessible locations near the danger area:
a) fire extinguisher
b) fire blanket
c) eye and face spray
d) emergency spray for parts of body
e) first aid kit
f) neutralizing solutions

(Additional to Section 2)

Requirements for Chemistry

Student Work Benches
a) 1 gas exhaust outlet for every two students, with a 4 in. screened opening and 100 CFM, to be used with plastic hood;
b) safety features.

Storage
a) vented section for acid storage on trays lined with inert material, floor drain;
b) tray storage for sets of acids, bases, solid reagents and solutions shown in Drawing 17.

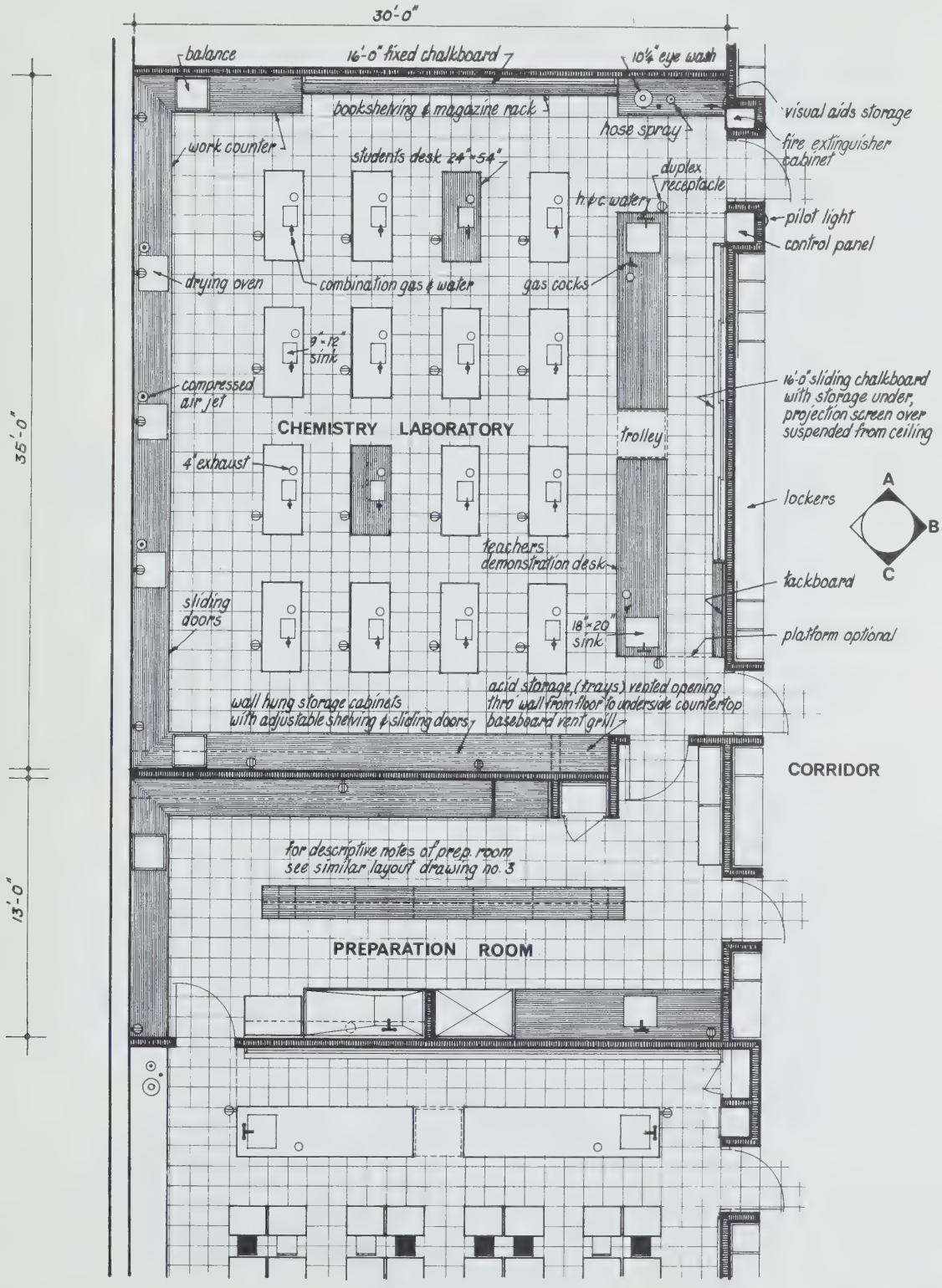
Demonstration Desk
a) compressed air;
b) two gas exhaust vents.

Preparation Room
a) vented cupboard for storage of fuming and volatile liquids, continuously running fan, pilot light, perforated shelves of inert materials, connected to cupboard in classroom as shown in Drawing No. 1;
b) fume hood, completely serviced with sink water, gas, electricity;
c) sturdy shelf for large bottles of stock solutions, 10 to 12 in. wide 18 in. above sink;
d) narrow shelves for storage of chemicals;
e) locked, fireproof storage for combustible chemicals;
f) pass through (optional);
g) area for student work (optional);
h) exit to corridor;
i) distillation apparatus with large storage tank.

Students' Projects
Chemistry Preparation Room

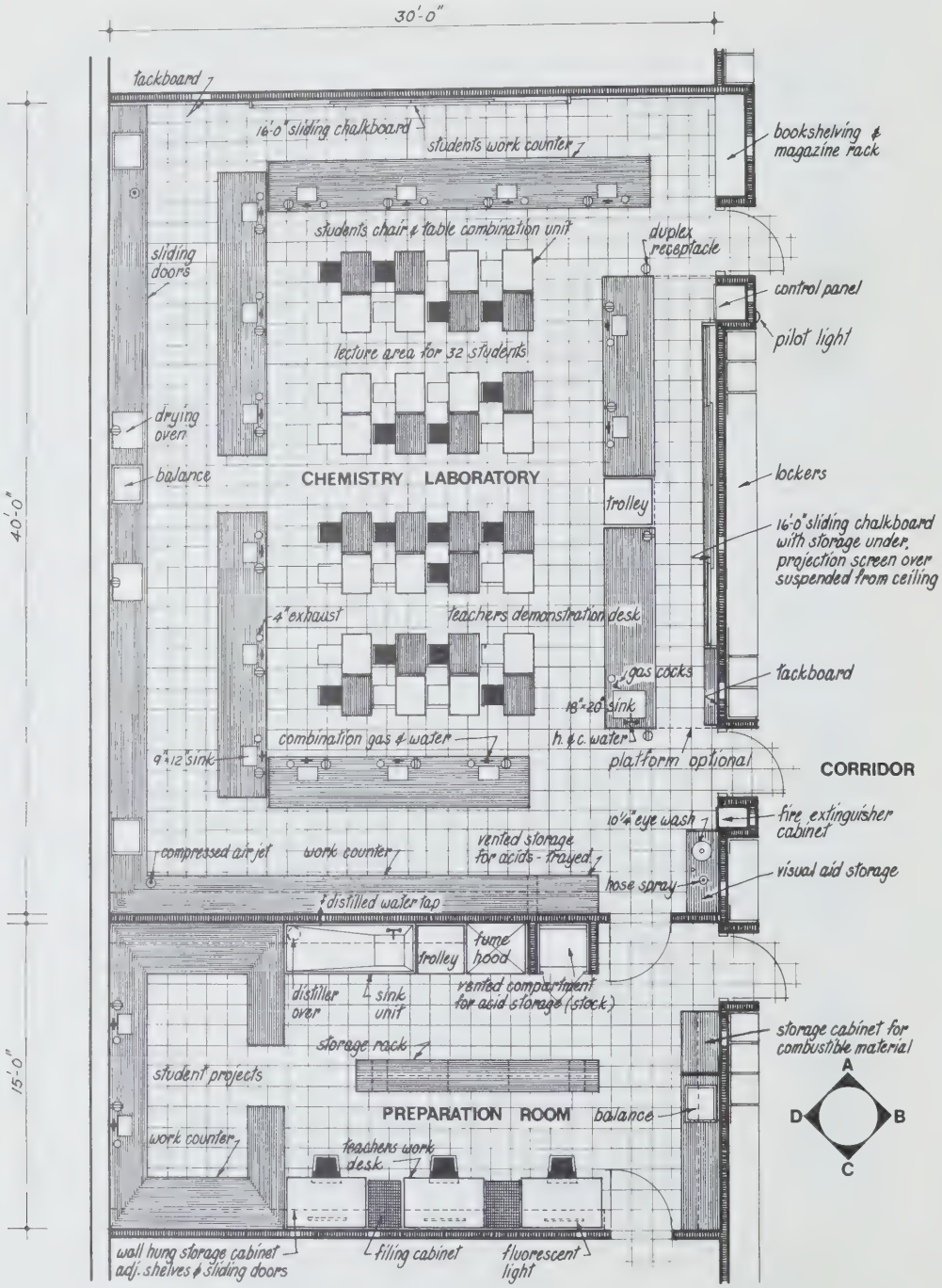
Chemistry Conventional Laboratory – floor plan C-1

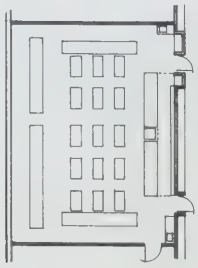
Drawing 1



Chemistry Perimeter Laboratory – floor plan C-2

Drawing 2



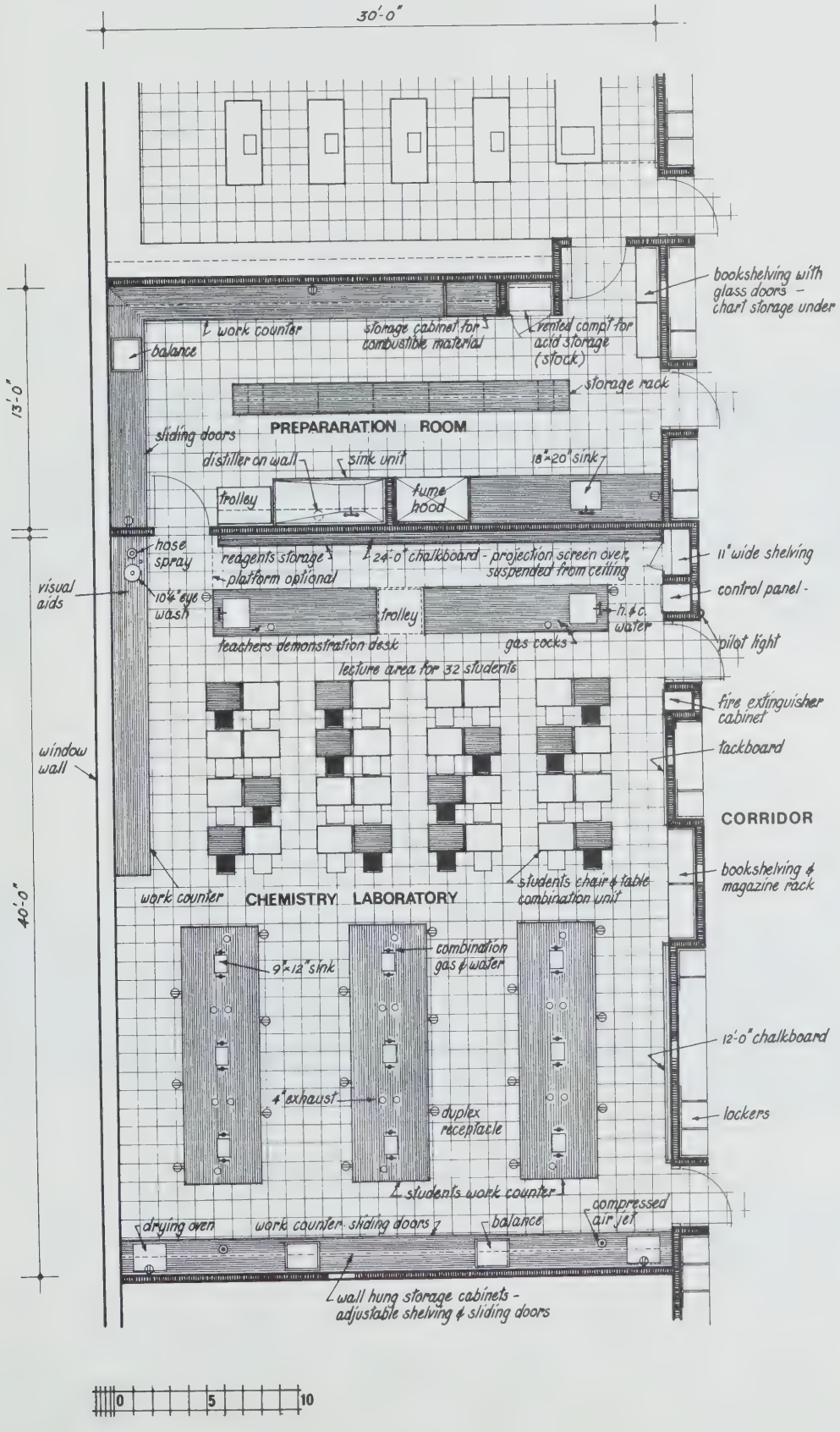


alternative layout for chemistry laboratory

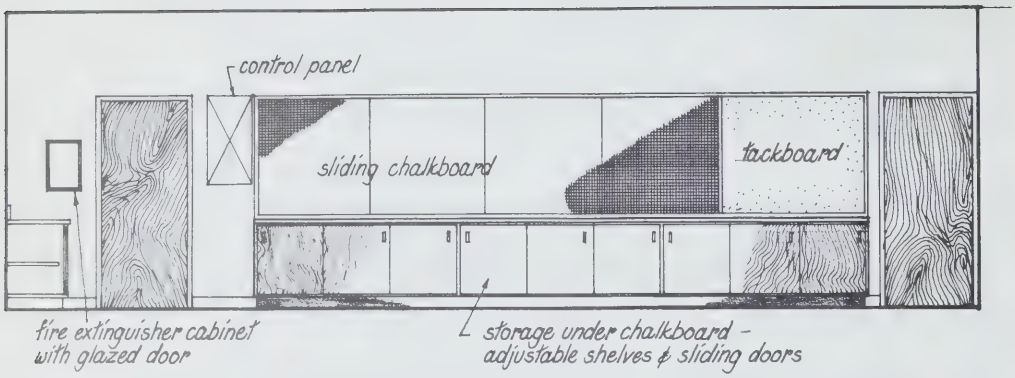
C-6

Combination Laboratory – floor plan C-3

Drawing 3

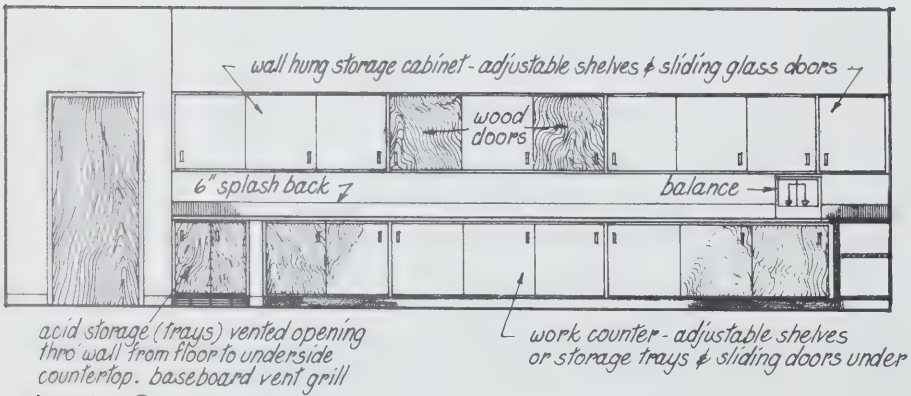


Drawing 4


control panel
sliding chalkboard
tackboard
fire extinguisher cabinet with glazed door
storage under chalkboard – adjustable shelves & sliding doors

elevation B

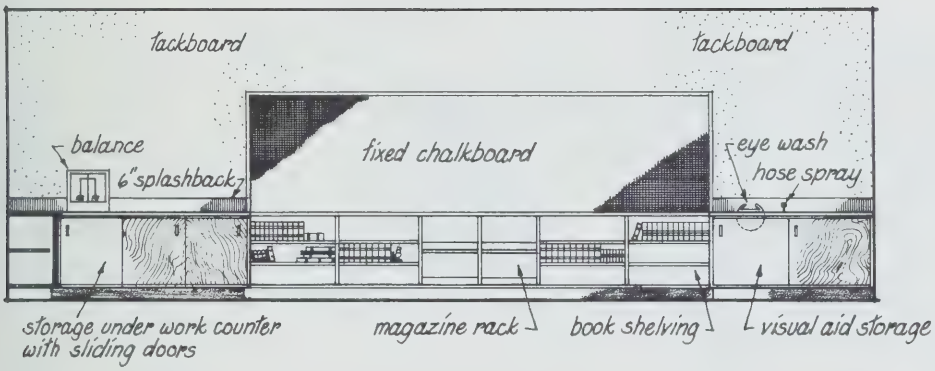
section


wall hung storage cabinet - adjustable shelves & sliding glass doors
wood doors
6" splash back
balance
acid storage (trays) vented opening thro' wall from floor to underside countertop. baseboard vent grill
work counter - adjustable shelves or storage trays & sliding doors under

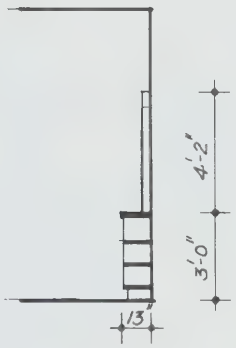
elevation C

section

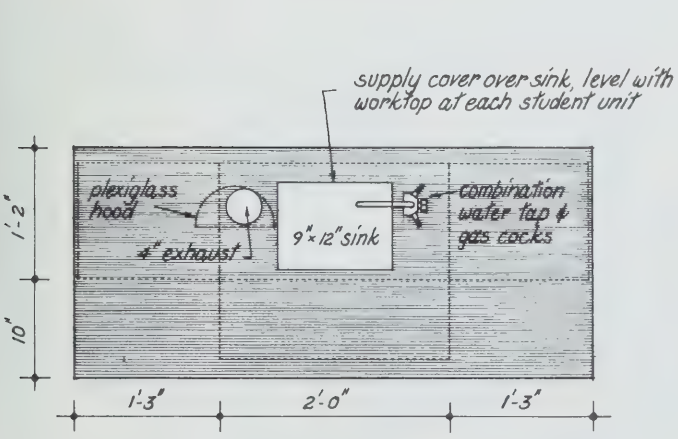
Drawing 4

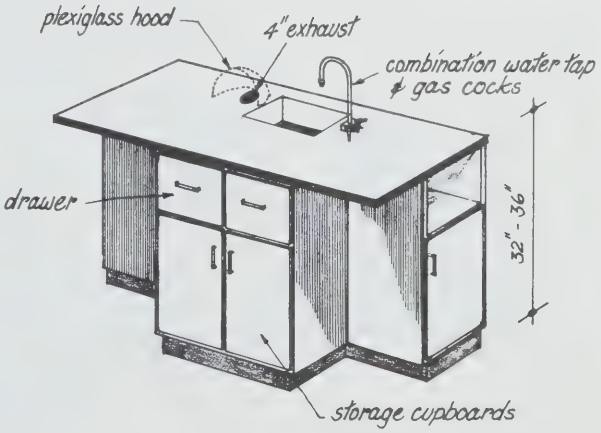


elevation A

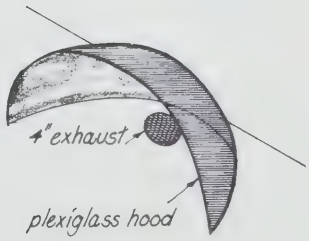


section



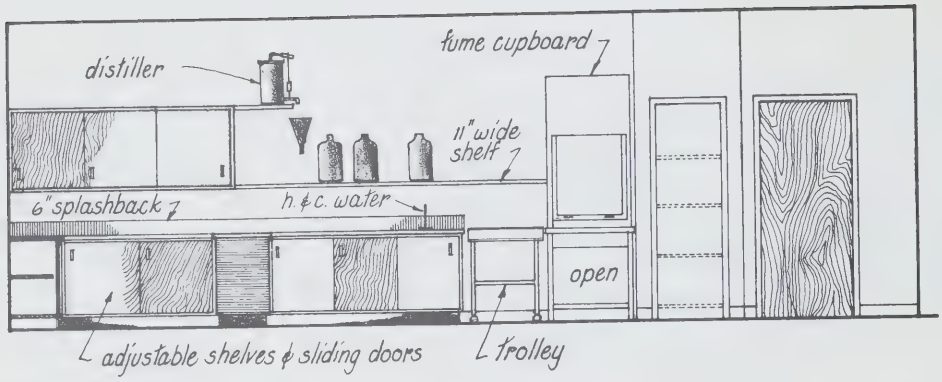


student unit

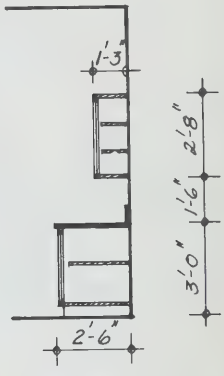


Preparation Room–elevations (for floor plan C-2)

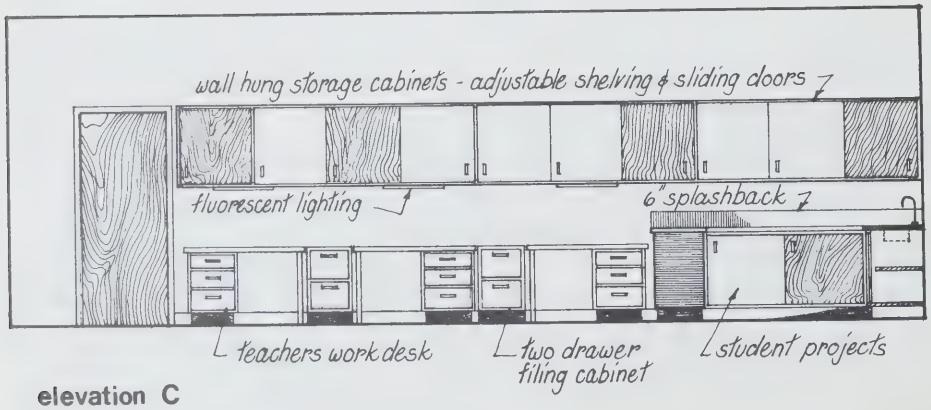
Drawing 5



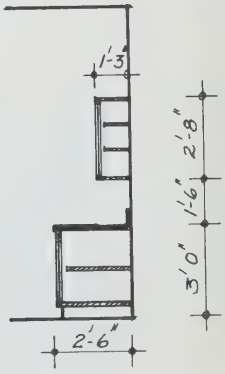
elevation A



section



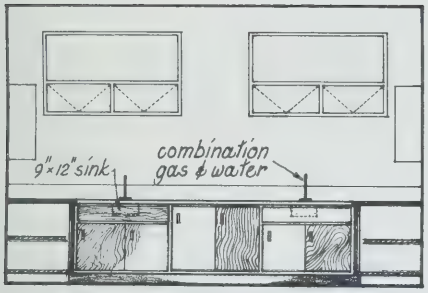
elevation C



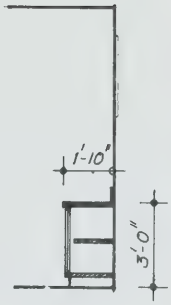
section

Preparation Room – elevations (for floor plan C-2)

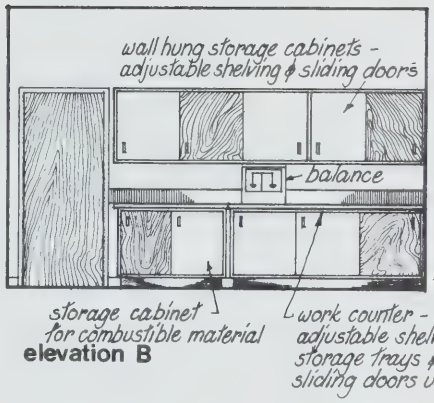
Drawing 5



elevation D

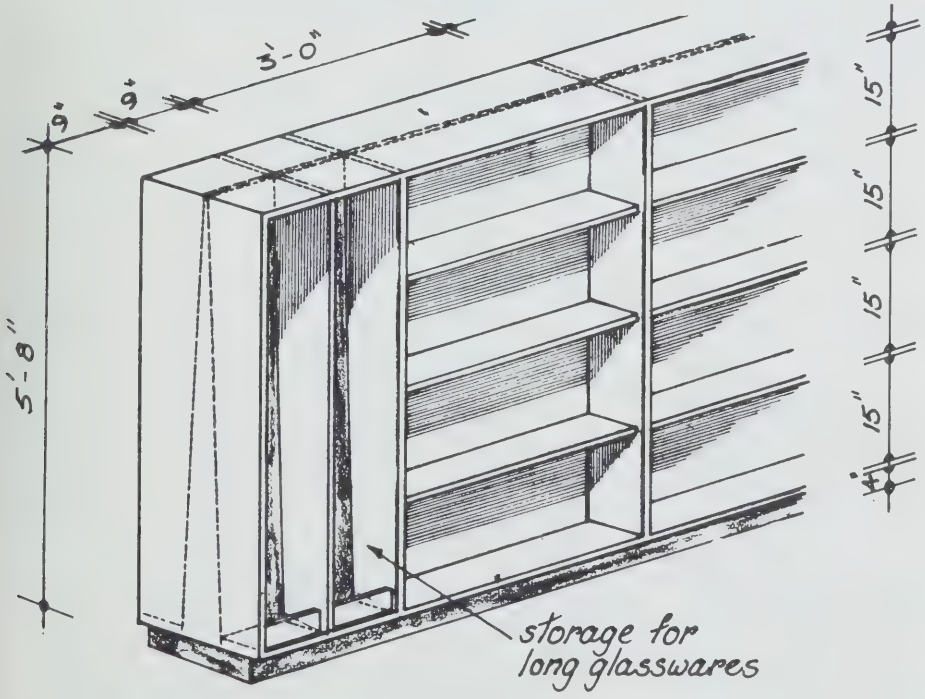


section

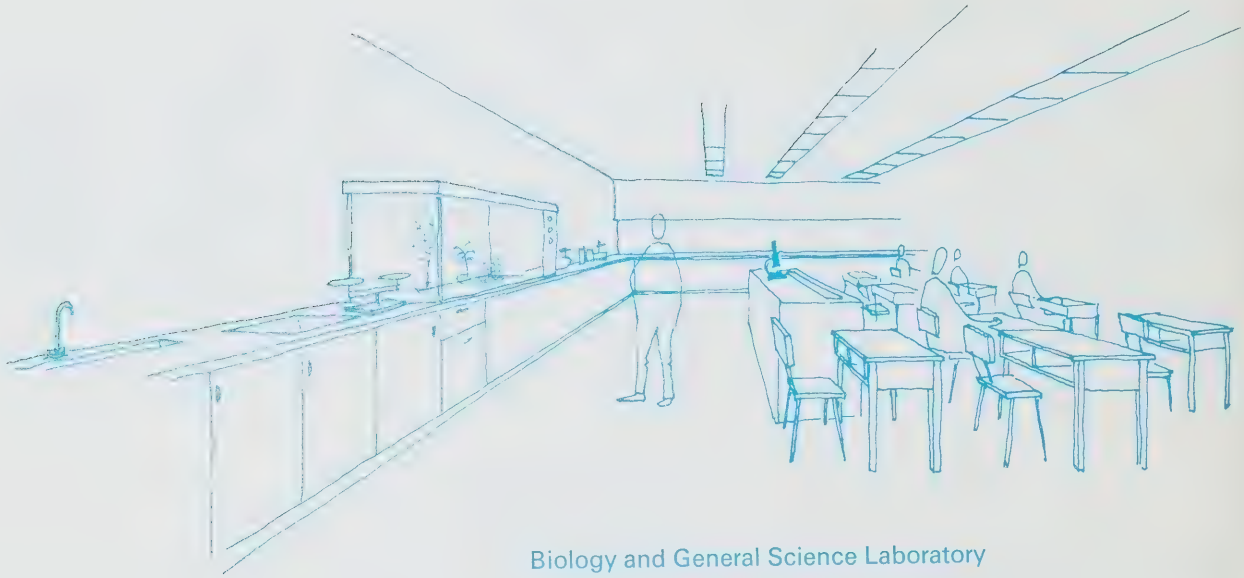


elevation B

section



solution rack



Biology and General Science Laboratory

There are three types of laboratories for biology and general science as shown in Drawings 6, 7, 8, 9, 10, 11, 17.

1. Conventional laboratory requirements (See Drawing No. 6)

a) The work counters may be used as additional work areas when more space is required and for special student research areas.

b) The ample chalkboard area is essential.

c) The trolleys may be used for distributing materials, as portable demonstration units and for housing the visual equipment.

d) The cupboards behind and below the chalkboards as shown in the drawings are valuable as a source of materials close to the teacher.

2. Combination Laboratory requirements (See Drawing No. 7)

a) The layout of this laboratory is particularly useful since the biospace projects into the working area and becomes an integral part of the laboratory.

b) The work counters, placed 4 ft. 6 in. apart, have trough sinks running their entire length. Stools are not necessary, even for work with microscopes.

c) The area for discussion, with chalkboards on two sides, contains right and left hand combination table and chair units with horizontal writing surfaces.

3. Perimeter Laboratories (See Drawings Nos. 8 and 9)

This type of laboratory is particularly well suited to the teaching of biology.

a) Students may face towards the centre of the room or the outside, depending on the layout of the work counters.

b) Stools are unnecessary.

c) The area for discussion can accommodate either four-legged tables, tablet arm desks or preferably table and chair combination units with horizontal writing surfaces.

d) If more than 30 students are in a particular class, the additional students can be accommodated at one of the work benches until such time as transfers can be effected.

Student Work Desks and Counters

a) In the conventional laboratory, students' work desks should be not less than 48 in. long and 30 in. wide. They should contain a sink. Gas, water and electrical outlets are essential.

b) Work counters in the combination laboratory (Drawing No. 7) should allow 5 lineal feet per station, for two students, each with water, gas and electrical outlet. There should be a minimum of 4½ ft. between the counters.

c) Perimeter work counters also require 5 lineal feet per station, each for two students, and services as described above.

Biology Laboratories

Special Features Common To Biology Laboratories

Facilities

There are certain features common to all good biology laboratories that should be emphasized.

1. The Biospace (See Drawing No. 11)

a) Since the biospace is the focal point of the biology laboratory, the remainder of the laboratory area should be organized around it.

b) The inclusion of a biospace means that the demonstration desk, student work areas and perimeter work areas should not be occupied with terraria, aquaria, cages and biology equipment.

c) As its name suggests, the biospace should contain *living* organisms, both plant and animal.

d) It may also include storage for preserved specimens, making it a centre for specimens of all kinds.

e) The biospace must be large enough to allow experiments to be conducted there.

f) Animal cages, terraria and aquaria should be mounted in another section.

g) The top of the biospace should be approximately 3 ft. high with sliding doors for access.
h) Climataria or other portable units could be substituted for the top half of the biospace either back-to-back or side-by-side. One disadvantage arising from this arrangement would be the impossibility of seeing through the top of the biospace.
i) The base of the biospace is designed to be simply a wide counter with certain storage areas. The counter on either side of the upper unit will be useful when students are working in or around the biospace.
j) The spaces in the lower unit are for shallow plastic trays with wax bottoms and airtight lids. This arrangement enables dissections to be pinned out and left from one lab period to the next without a loss of moisture or the escape of irritating odours.
k) Other cupboards should be large enough to contain the large drums of specimens commonly purchased from biological suppliers.
l) Bins should be provided containing different types of earth such as sand, clay, humus for use in certain soil experiments. Peat moss, vermiculite and perlite are needed for growing seedlings and cuttings.
m) The biospace should have lights that may be controlled by an electrical interval timer. The plant growth area should be separately controlled. Normally, 1,000 footcandles is adequate for growth but to overcome shading of lower plants, 1,500 footcandles may be required. Light intensity is measured at a distance of 3 feet below the light source.
n) The temperature must be regulated although the required range of 60°F to 70°F is adequate for most plants and animals. Providing the humidity and lighting can be controlled, classroom temperatures may be satisfactory. Since there are fluctuations over the week-ends, holidays and at night, controls of temperature are required.
o) Humidity must be regulated at about 60% for normal plant growth and the comfort of most of the animals. Restricted air movement can normally accomplish this and glass or polyethylene covers are sufficient to prevent water loss.
p) The biospace should be ventilated to expel the odours which naturally accrue from living organisms.
q) A water supply should be included in the biospace. possibly in the form of a large sink. It is recommended that the entire floor of the biospace be waterproofed and have a raised lip around the perimeter with a shallow trough in the centre leading to a drain.
r) The control panel should be placed at one end of the biospace.

2. Clean-up Area
a) The clean-up areas should include wide, deep wash-up sinks at the most useful locations in the laboratory. Here the cleaning and preparation of specimens can be efficiently carried out with a minimum of confusion.
b) It is suggested that each student's work area contain paper towels and soap dispensers.
c) Receptacles for debris are essential and should be built in at various points in the laboratory.

3. Research Facilities
a) Research areas are becoming more and more important as student research is emphasized in modern science courses.
b) Reference books should be readily available in the laboratory.
c) Perimeter work benches might be used as project areas in the conventional or combination laboratory.
d) A part of the preparation room might be set aside for student research.
e) Areas such as (c) and (d) above must contain the standard utilities of gas, water and AC electrical outlets.

4. Storage
a) Storage space must be provided for specimens which are in use over extended periods of time. If the tote space arrangement as described in the biospace is not available, then facilities should be provided elsewhere in the room or preparation area.

b) Desks should have adequate room to accommodate microscopes.
c) Dissection materials and other class biology equipment should be kept in a drawer in the desk where they are readily available.
d) Cupboards should be designed with room enough for large drums of specimens.
e) A refrigerator is necessary for the storage of perishable specimens. Space and power outlets should be provided, preferably in the preparation room.
f) Boxes of class sets of slides are best organized on specific shelves rather than jumbled together in drawers.
g) Charts are best stored horizontally in racks which allow classification and easy access to the materials.
h) Filing cabinets are necessary for the storing of transparencies and other biological materials.
i) The many models and mounted specimens of a biology lab should be displayed in tall, glassed-in cupboards so that they may be on view to stimulate curiosity and interest in the students.

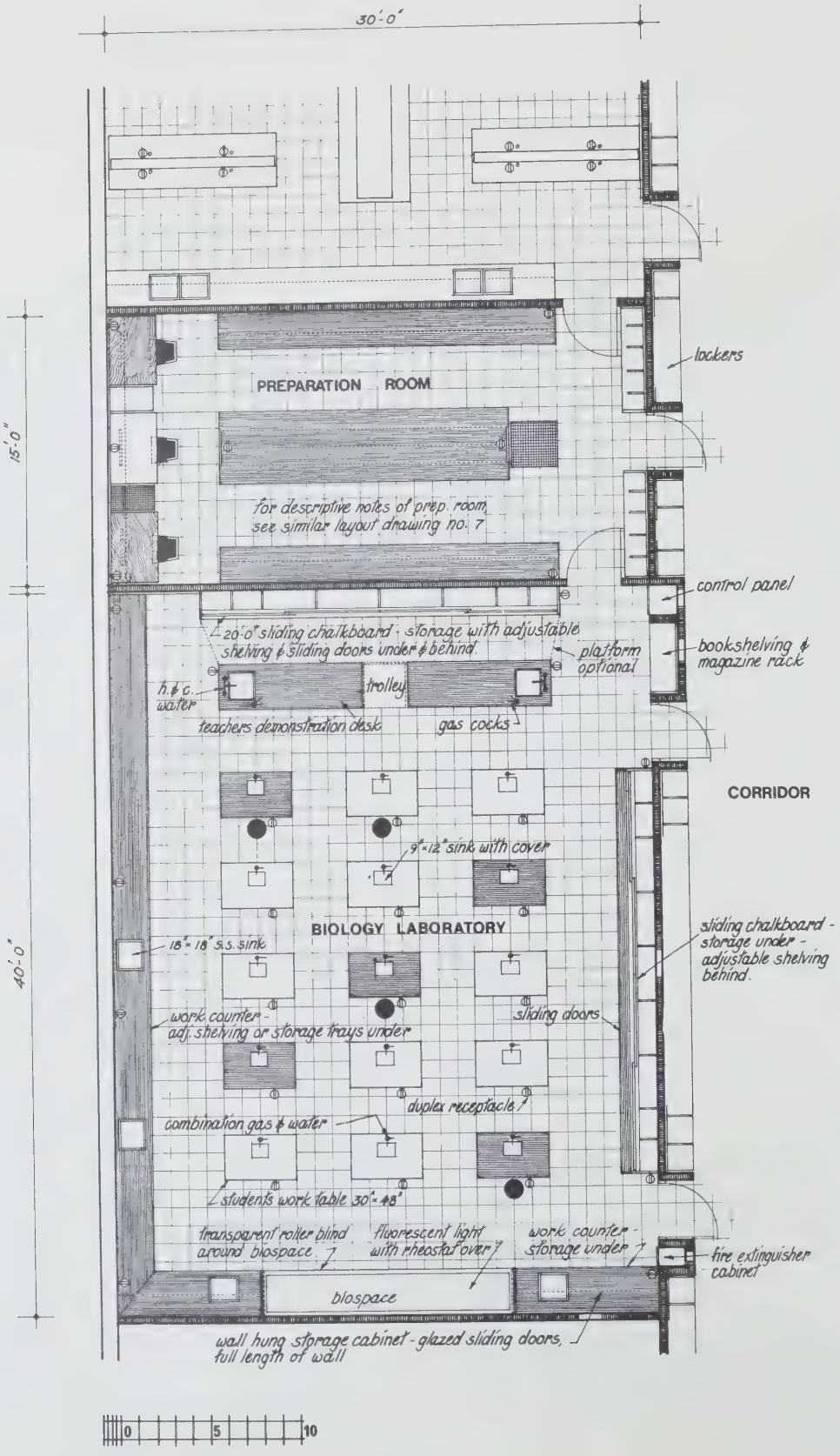
5. Visual Aids
a) Electrical outlets should be positioned for proper use of equipment.
b) For display purposes, tackboard areas should be extensive.
c) For demonstration purposes, portable units with moveable backdrops and provision for illumination are very effective.

6. Teacher's Demonstration Desk
a) This desk should be at least 12 ft. long and 30 in. wide.
b) The desk may be divided in two, the space between the two sections being made large enough to accommodate a trolley This allows demonstration material to be prepared in advance on the trolley and to be easily moved to the desk.
c) One section of the demonstration desk can be used as a work station for two students.

7. Preparation Room
a) The preparation room will probably have to accommodate three teachers and should therefore have suitable space and furniture for them.
b) It should be emphasized that the preparation room is *not* a storeroom, although some storage is permissible provided it does not interfere with the working function of the room.
c) The preparation room may be placed at either end of the laboratory.
d) Consideration might be given to placing the biospace in the preparation room.
e) There must be enough space for filing cabinets and trolleys.
f) Services must include electrical outlets, gas and water outlets and at least one large sink for the preparation of specimens.

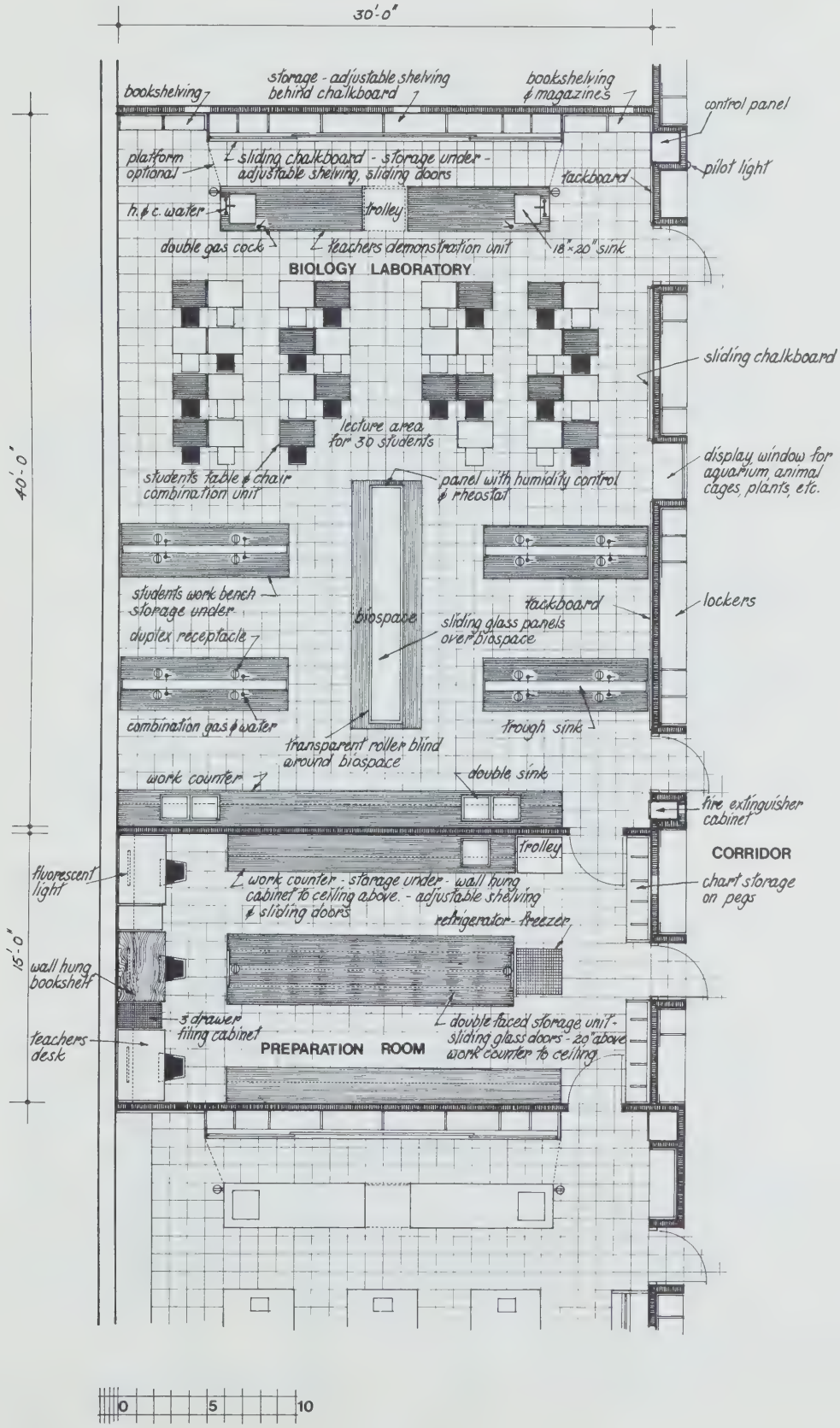
Conventional Laboratory – floor plan B-1

Drawing 6



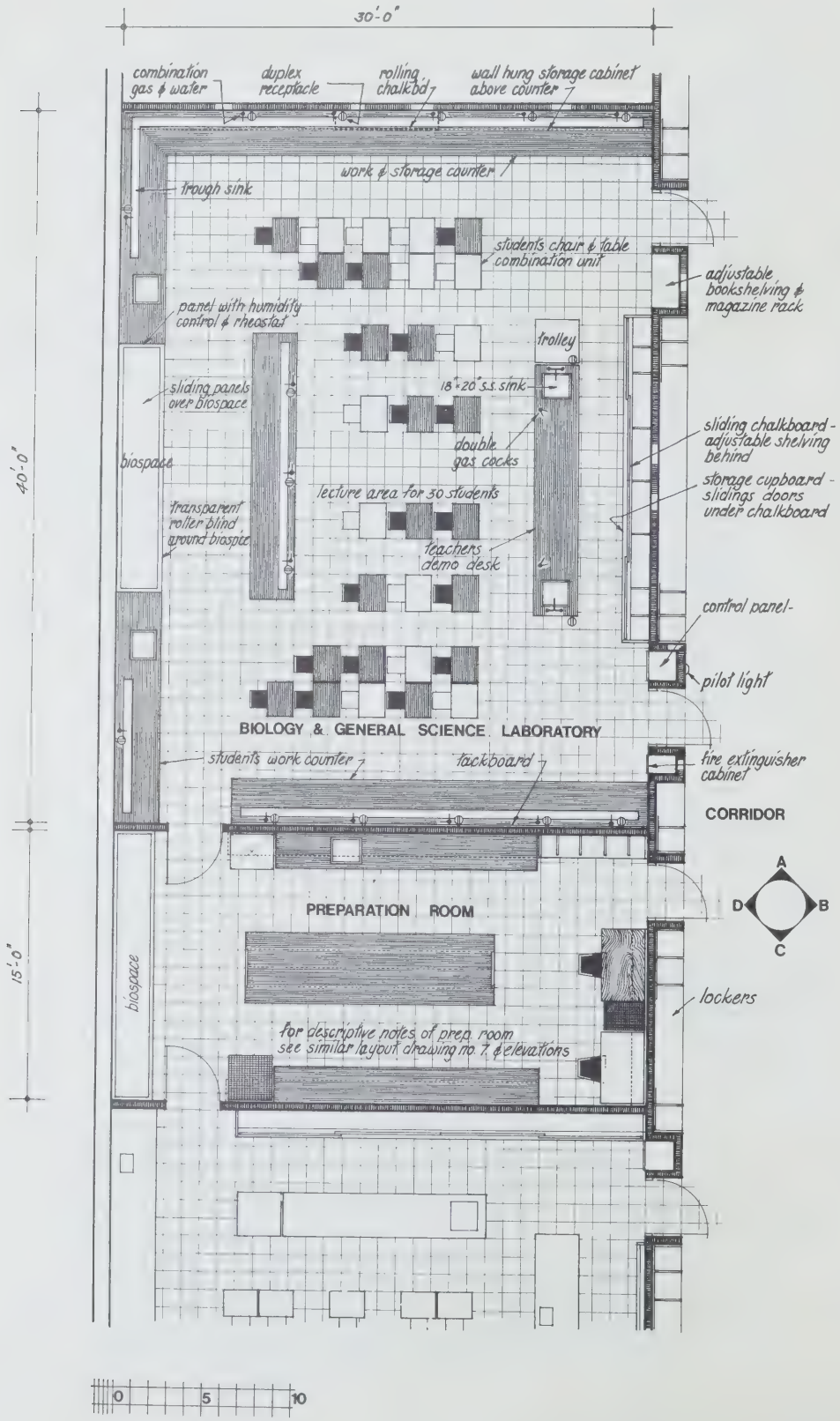
Combination Laboratory – floor plan B-2

Drawing 7



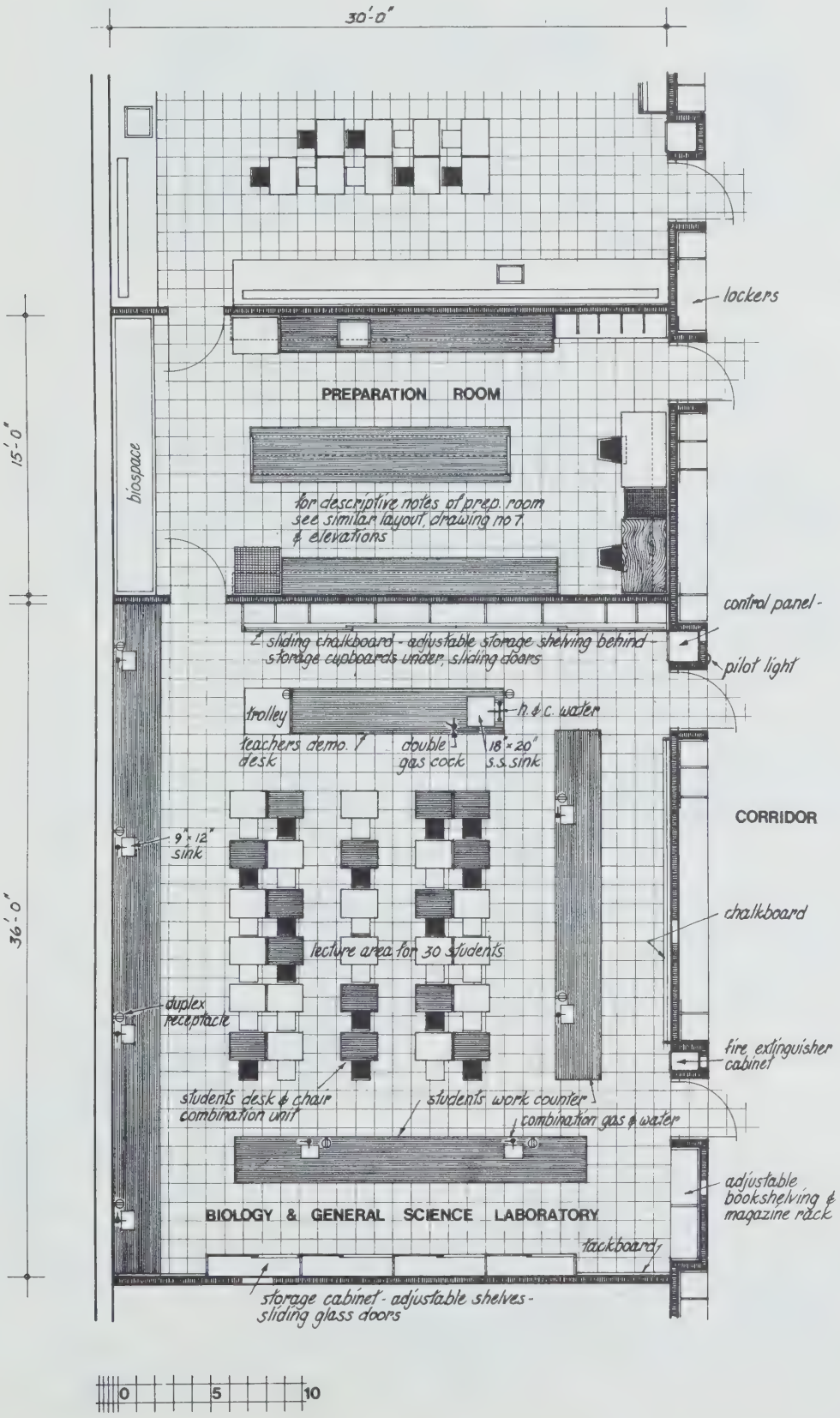
Perimeter Laboratory – floor plan B and GS-A

Drawing 8



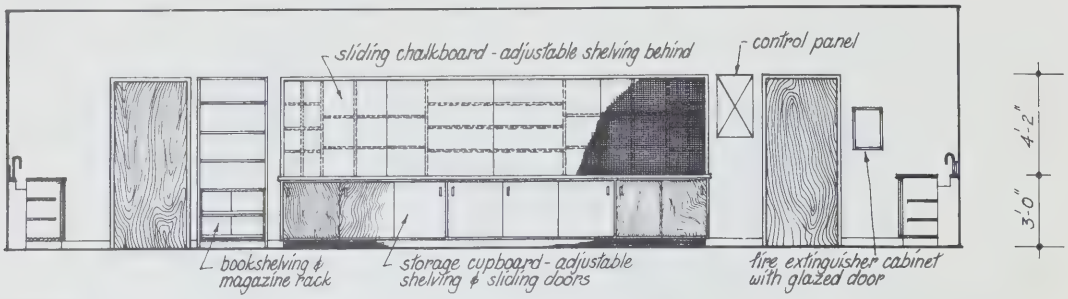
Perimeter Laboratory – floor plan B and GS-B

Drawing 9

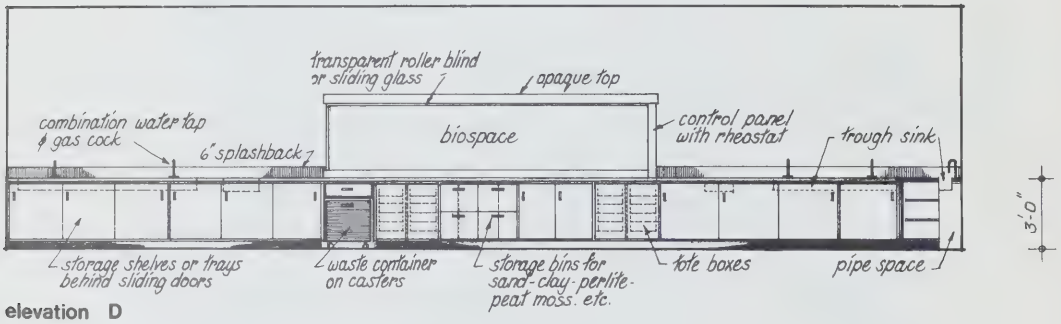


Perimeter Laboratory
–elevations (for floor plan B and GS-A)

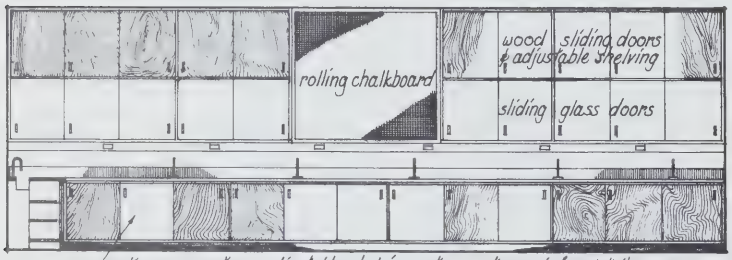
Drawing 10


sliding chalkboard - adjustable shelving behind
control panel
4'-2"
3'-0"
bookshelving & magazine rack
storage cupboard - adjustable shelving & sliding doors
fire extinguisher cabinet with glazed door

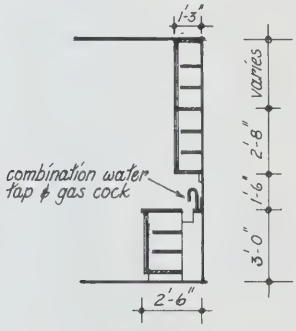
elevation B



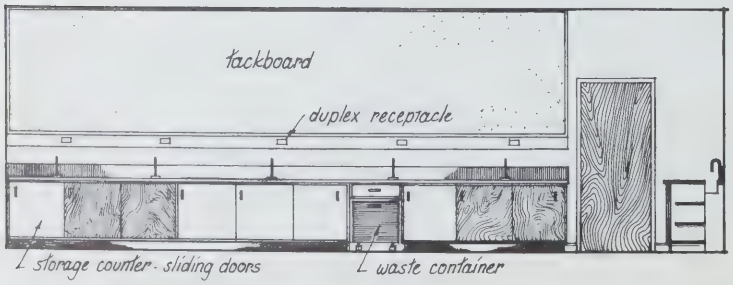
elevation D


rolling chalkboard
wood sliding doors & adjustable shelving
sliding glass doors
storage counter - adjustable shelving - storage trays (for details see typical detail sheet of storage counter unit showing above, for science labs)

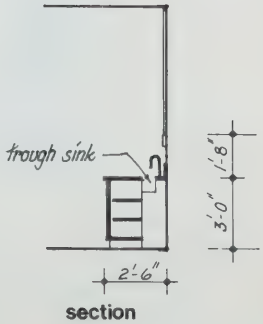
elevation A



section



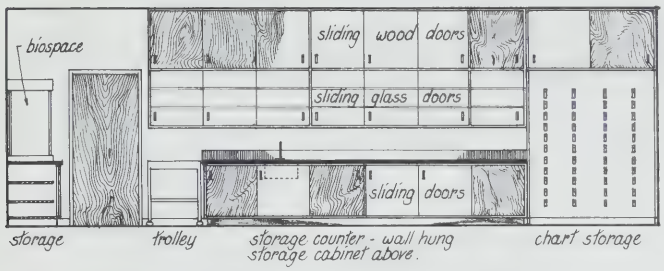
elevation C



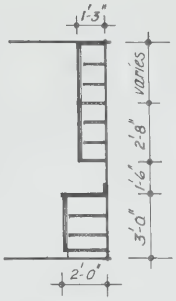
section

Biology and General Science Preparation Room –elevations (for floor plan B and GS-A)

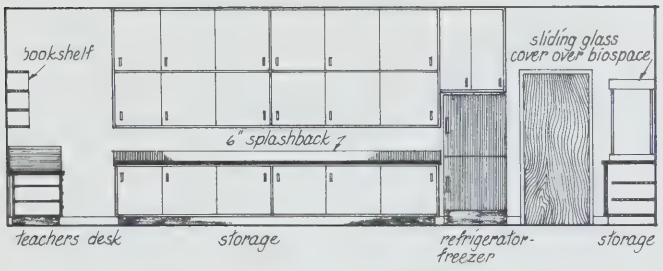
Drawing 11



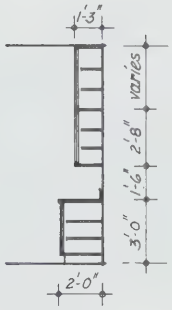
elevation A



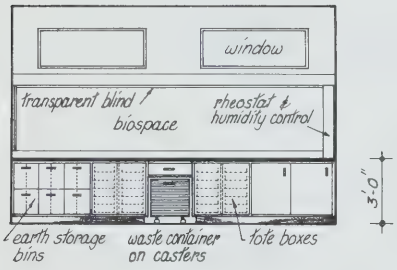
section



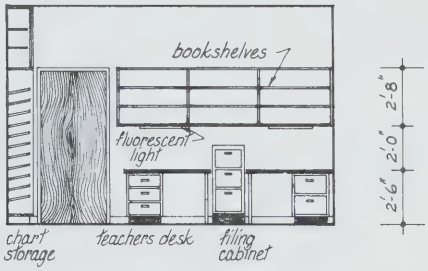
elevation C



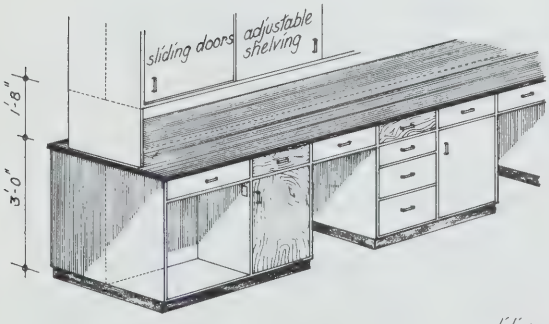
section



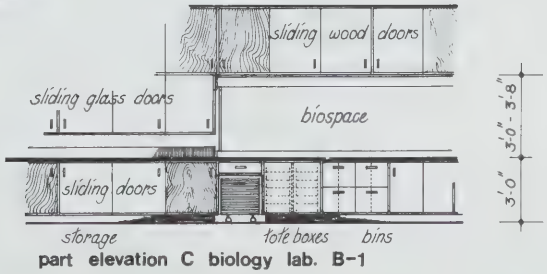
elevation D



elevation B



double faced storage cabinet & work counter (prep. rooms)



part elevation C biology lab. B-1

Physics and General Science Laboratory

Laboratories For Physics And General Science are shown in Drawings 12, 13, 14, 15, 16.

1. Conventional Laboratory (See Drawing No. 12)
This laboratory is a very flexible arrangement comprising perimeter counters with 12 work areas, each containing a sink (with cover), a combination water and gas outlet, and a 110 volt A.C. outlet. A similar unit with further working space for students is located adjacent to the demonstration desk.

The middle of the room is used as a space for general activities. It is recommended that moveable tables be used here so that varying sizes of working areas may be obtained when tables are put together. For example, if tables are butted end to end, the continuous surface can be used for motion experiments.

Alternatively, some tables can be placed against perimeter counters for additional working area.

If moveable tables are used, 110 volt A.C. outlets must be installed at floor level. At least 15 such outlets will be required. Fixed laboratory work desks may be used in place of the tables if these are preferred. Each desk should be serviced with electricity.

Storage space in this type of laboratory is not a problem since cupboards can be provided both as units under the work counters and as wall-hung units above the counters.

2. Perimeter Laboratory (See Drawing No. 13)
This layout is very versatile. The location of the work counters allows the students to face inwards while working. The centre area of the room is a space for discussion and use of reference material, etc. The work counters are serviced, as in the conventional laboratory, with sink, water, gas and electricity. The furniture in the centre area can be either individual combination desks with writing tablets, or moveable tables as shown in the plans for chemistry laboratories. Storage space is available in the cupboards under the work counters, behind the chalkboard and against the wall at the rear of the room. Shelves should be adjustable.

A further advantage of this layout is that the instructor can maintain supervision easily and can direct activities from either of the two chalkboards. One chalkboard is near the preparation room and the other close to the service panel at the entrance door.

Drawing No. 14 shows another arrangement for a perimeter laboratory in which the students face outward when working at the experimental counters.

Flexibility and good control are also achieved and there is a minimum of traffic congestion. The work counters are serviced as usual, moveable tables are provided, as are storage cupboards similar to those shown in the other laboratories. The demonstration desk and chalkboards are adjacent to the central panel and preparation room.

Drawings Nos. 15 and 16 show elevations and details of storage units and work counters, chalkboard, etc.

3. Preparation Room
a) The preparation room is not to be considered a storage room although some equipment for demonstration purposes will be kept there.
b) It will probably accommodate three teachers. Desks and filing cabinets will therefore be required.
c) The preparation room should also have space for trolleys adjacent to the work counter, allowing preparation of the apparatus to be used by the teacher in the laboratory.
d) Provision should be made in the preparation room for student research. The work area should be fitted with appropriate storage, knee spaces and services.
e) Book cupboards, cart storage and some tackboard are also recommended.

4. Students' Work Tables
a) Moveable tables are highly recommended for physics laboratories.
b) They should be a minimum of 24 in. by 48 in. and have a 2 in. overhang for the use of clamps.
c) Since very few experiments require gas or water, no services are required in the table. Electrical outlets

must be available close by, preferably mounted in and flush with the surface of the floor.

Recommended Features not Specifically Mentioned in Section 2

a) a 2 in. overhang of tops of benches on demonstration desk and work benches in both the laboratories and preparation rooms;

b) storage area in preparation room for charts, glass tubing, metre sticks and long retort stand rods;

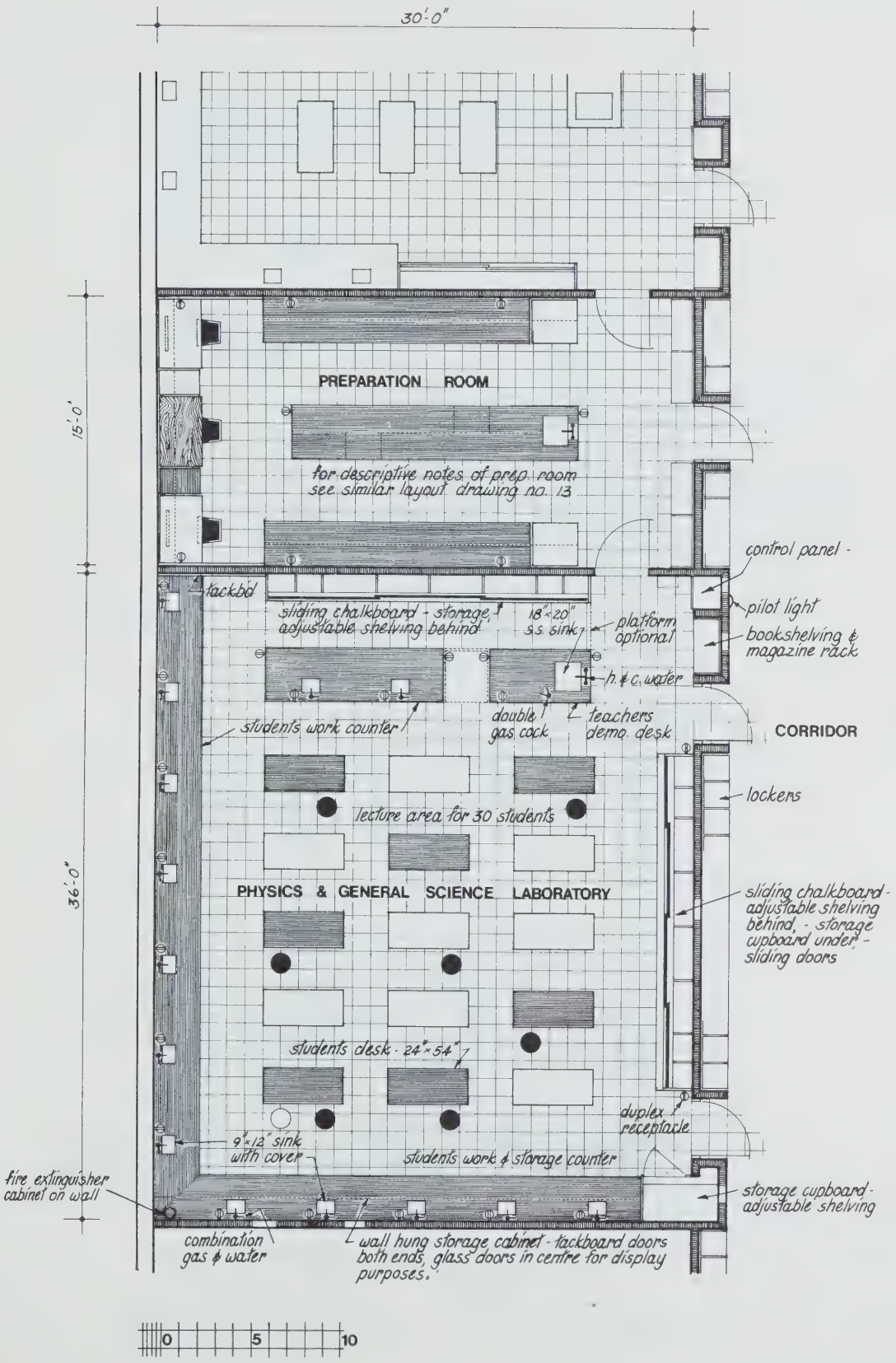
c) mounting board about 6 ft. by 8 in. in the ceiling above demonstration desk. This board is useful for attachments such as hooks required for special demonstrations;

d) large storage cupboard in laboratory for tall equipment;

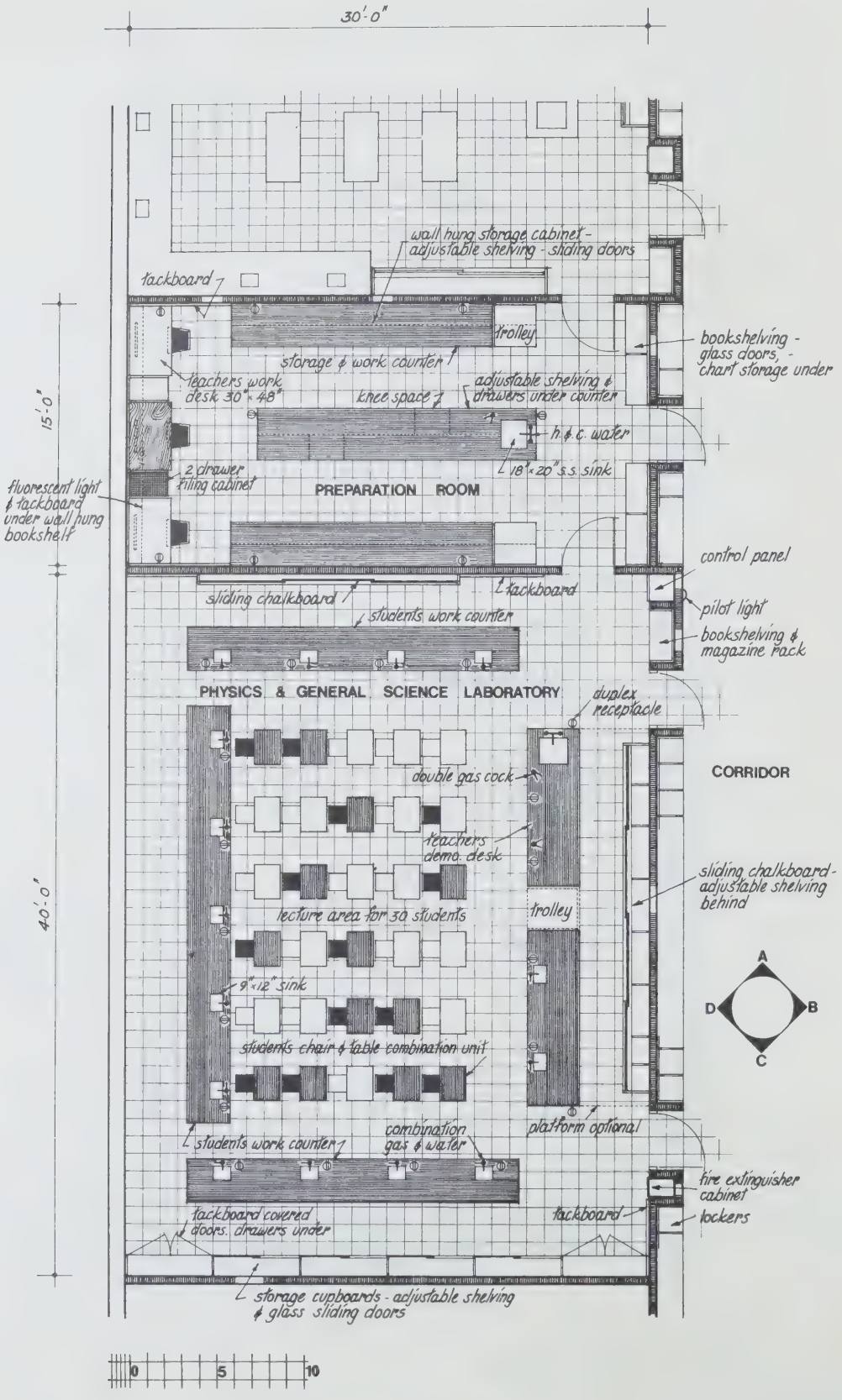
e) all sinks with cover flush with table top.

Conventional Laboratory – floor plan P-1

Drawing 12

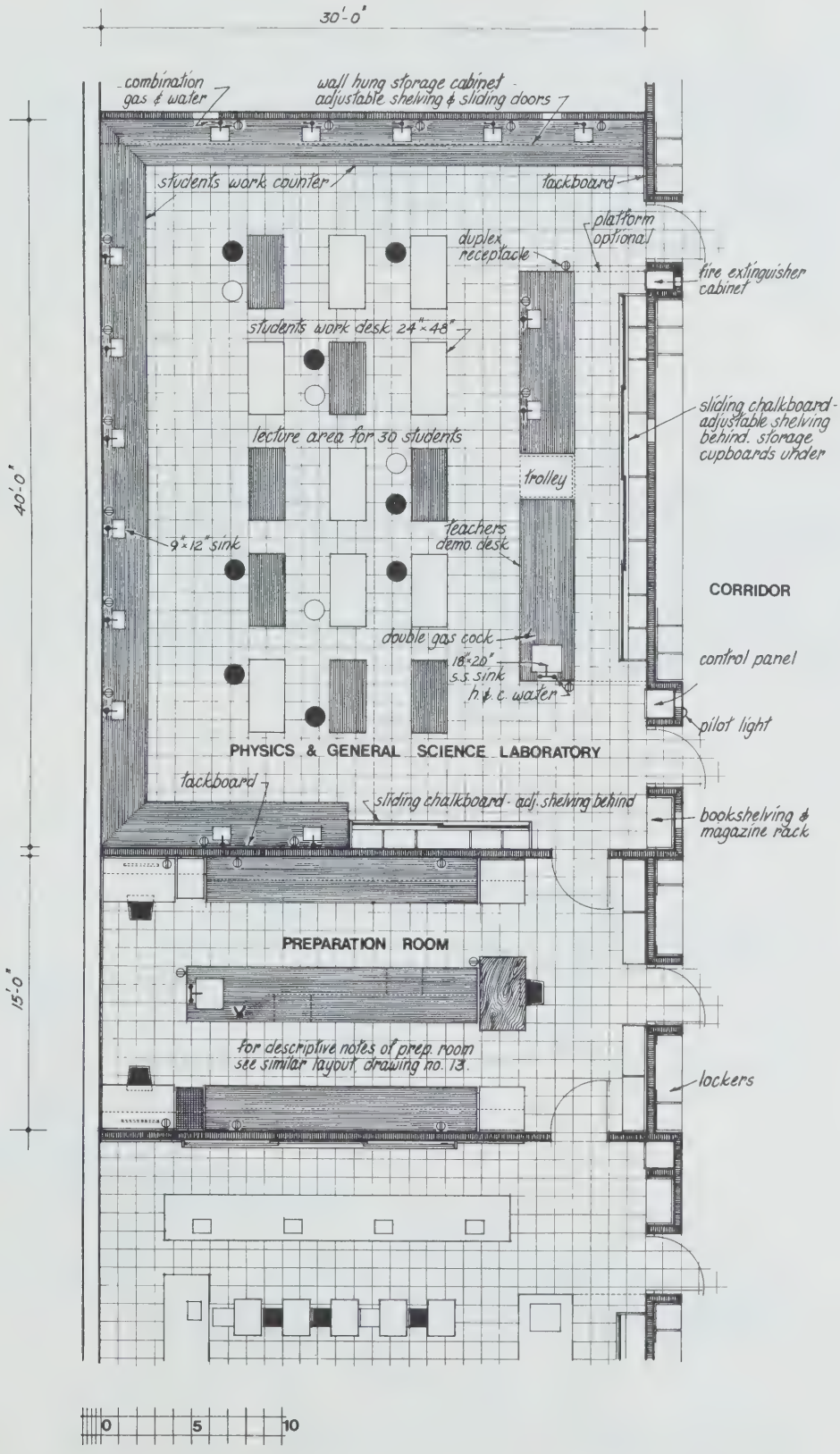


Drawing 13


30'-0"
15'-0"
40'-0"
wall hung storage cabinet - adjustable shelving - sliding doors
tackboard
trolley
bookshelving - glass doors, - chart storage under
storage & work counter
teachers work desk 30" x 48"
knee space
adjustable shelving & drawers under counter
h. & c. water
18" x 20" s.s. sink
2 drawer filing cabinet
fluorescent light & tackboard under wall hung bookshelf
PREPARATION ROOM
control panel
pilot light
bookshelving & magazine rack
sliding chalkboard
tackboard
students work counter
PHYSICS & GENERAL SCIENCE LABORATORY
duplex receptacle
CORRIDOR
double gas cock
teachers demo. desk
sliding chalkboard - adjustable shelving behind
lecture area for 30 students
trolley
9" x 12" sink
students chair & table combination unit
A
B
C
D
students work counter
combination gas & water
platform optional
fire extinguisher cabinet
tackboard
lockers
tackboard covered doors, drawers under
storage cupboards - adjustable shelving & glass sliding doors
0
5
10

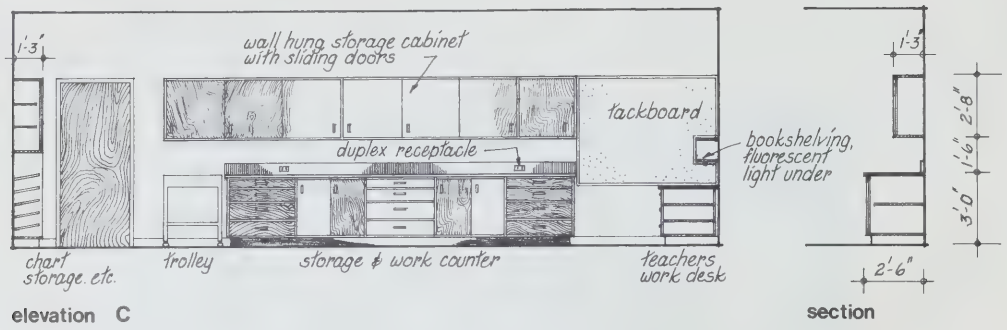
Perimeter Laboratory – floor plan P-3

Drawing 14



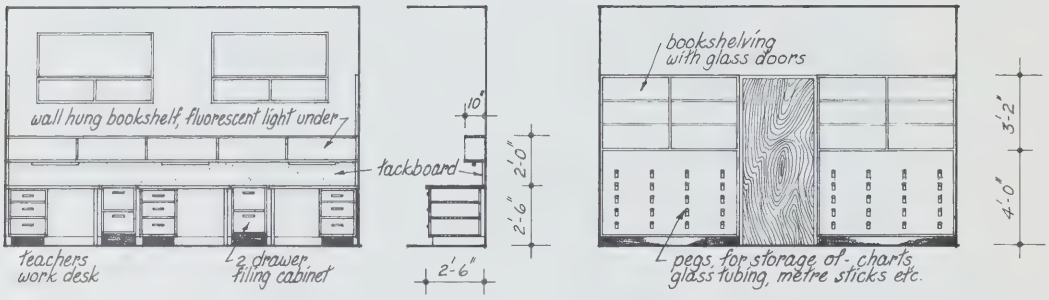
Preparation Room–elevations (for floor plan P-2)

Drawing 15



elevation C

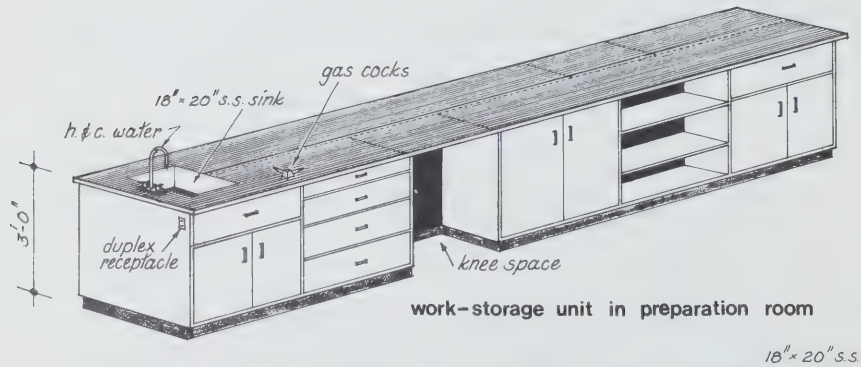
section



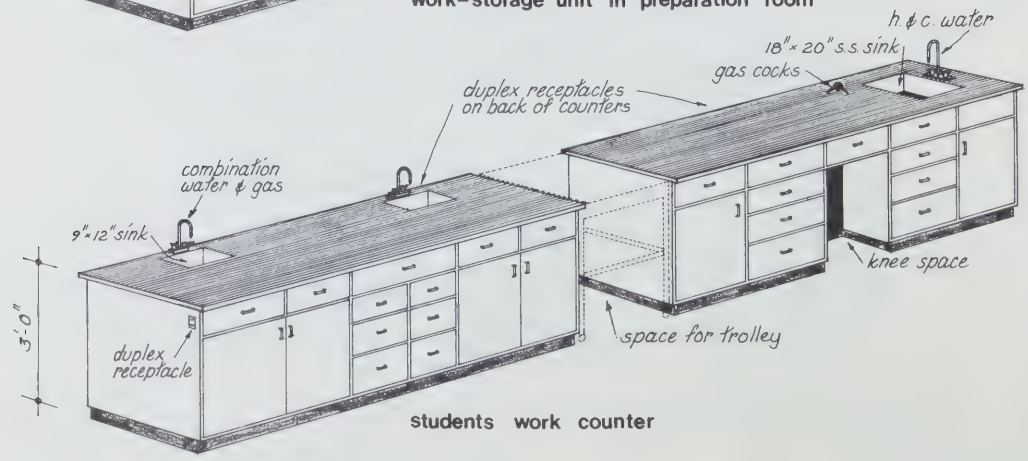
elevation D

section

elevation B



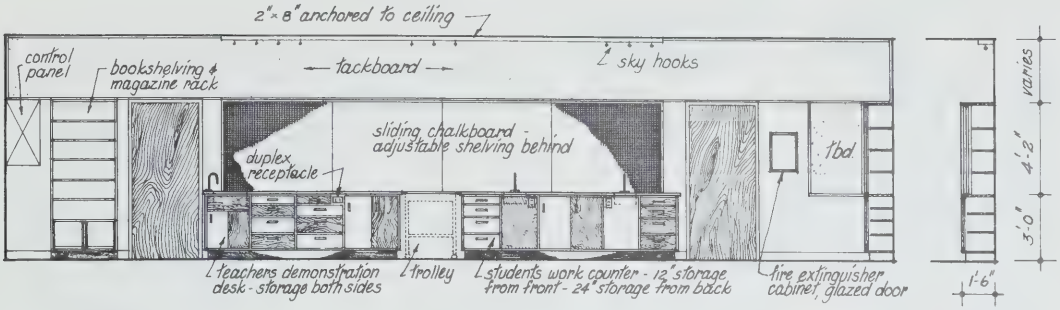
work–storage unit in preparation room



students work counter

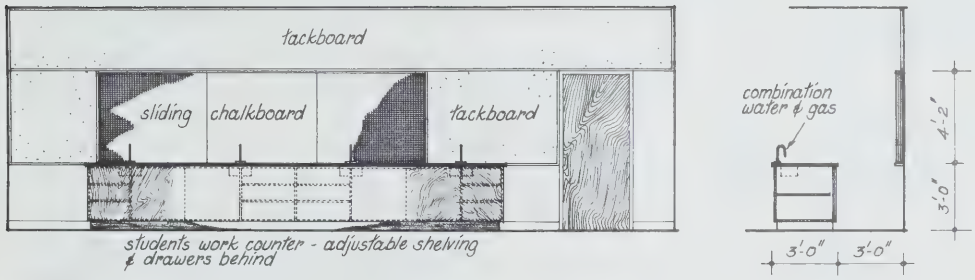
Perimeter Laboratory–elevations (for floor plan P-2)

Drawing 16



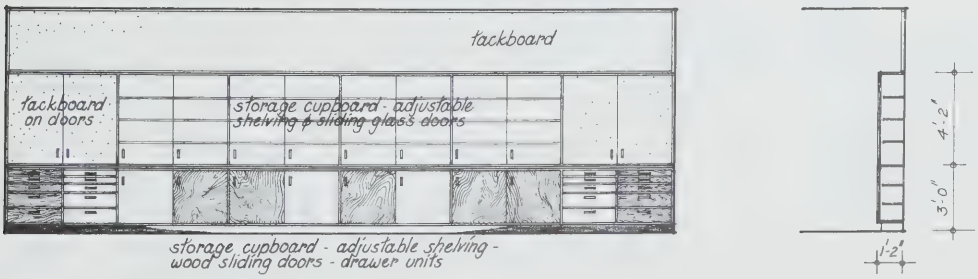
elevation B

section



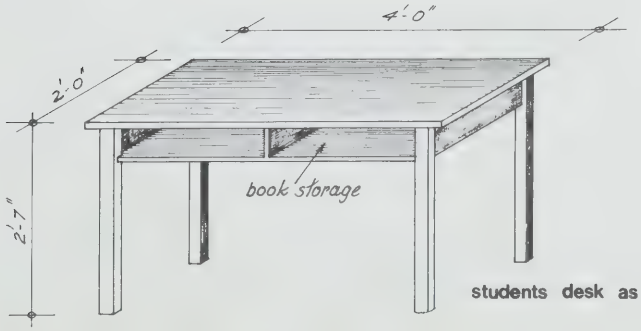
elevation A

section


tackboard
tackboard on doors
storage cupboard - adjustable shelving & sliding glass doors
storage cupboard - adjustable shelving - wood sliding doors - drawer units
4'-2"
3'-0"
1'-2"

elevation C

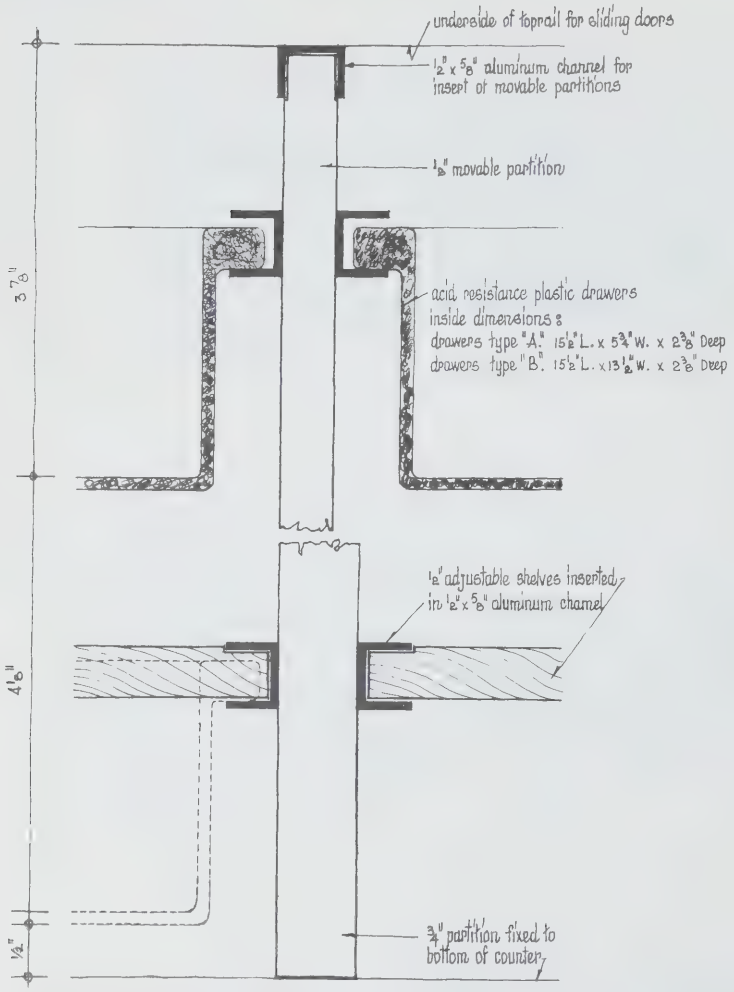
section



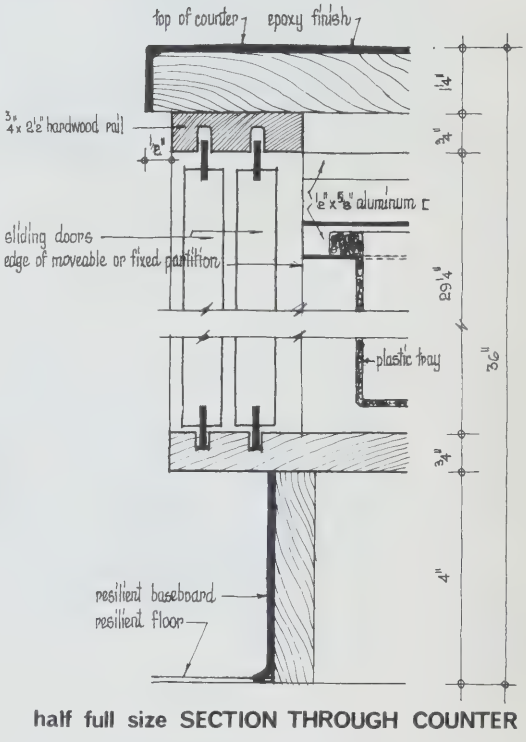
students desk as in P-3

Details of Storage Counters in Labs equipped with interchangeable partitions

Drawing 17


underside of toprail for sliding doors
½" x ⅝" aluminum channel for insert of movable partitions
½" movable partition
acid resistance plastic drawers inside dimensions:
drawers type "A" 15½"L. x 5¾"W. x 2⅜" Deep
drawers type "B" 15½"L. x 13½"W. x 2⅜" Deep
½" adjustable shelves inserted in ½" x ⅝" aluminum channel
¾" partition fixed to bottom of counter
37⅞"
41⅛"
½"

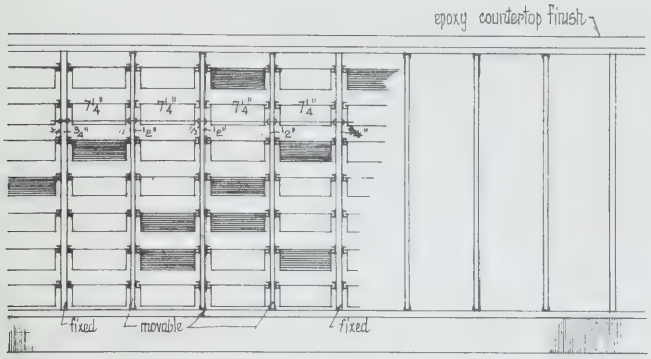
full size SECTION THROUGH STORAGE COUNTERS



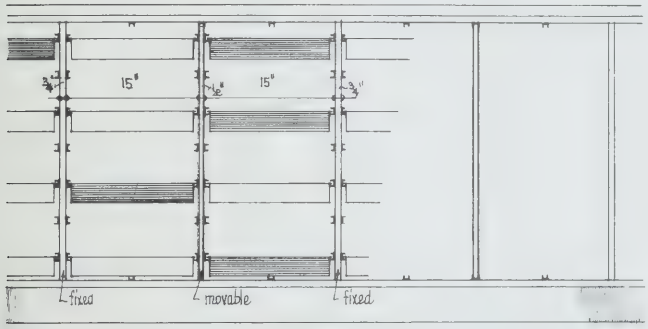
half full size SECTION THROUGH COUNTER

Details of Storage Counters in Labs equipped with interchangeable partitions

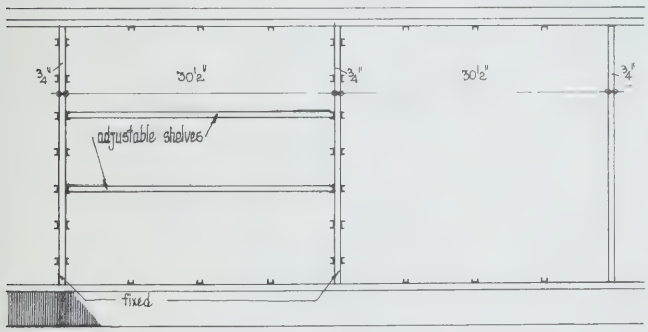
Drawing 17



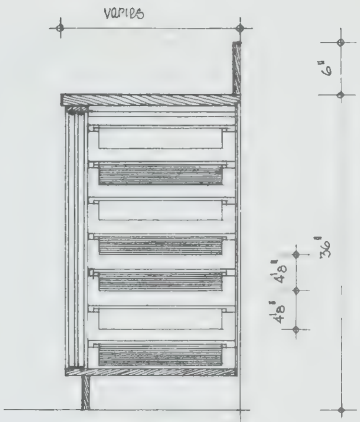
ELEVATION TYPE 'A' sliding doors removed



ELEVATION TYPE 'B' sliding doors removed



ELEVATION TYPE 'C' sliding doors removed



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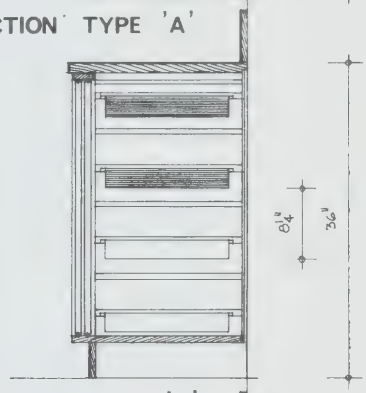

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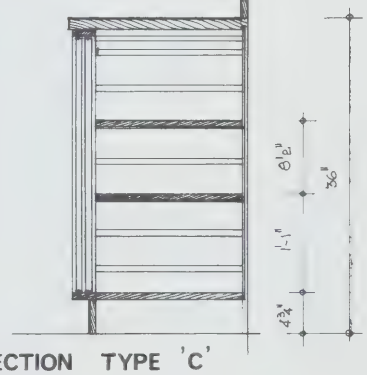

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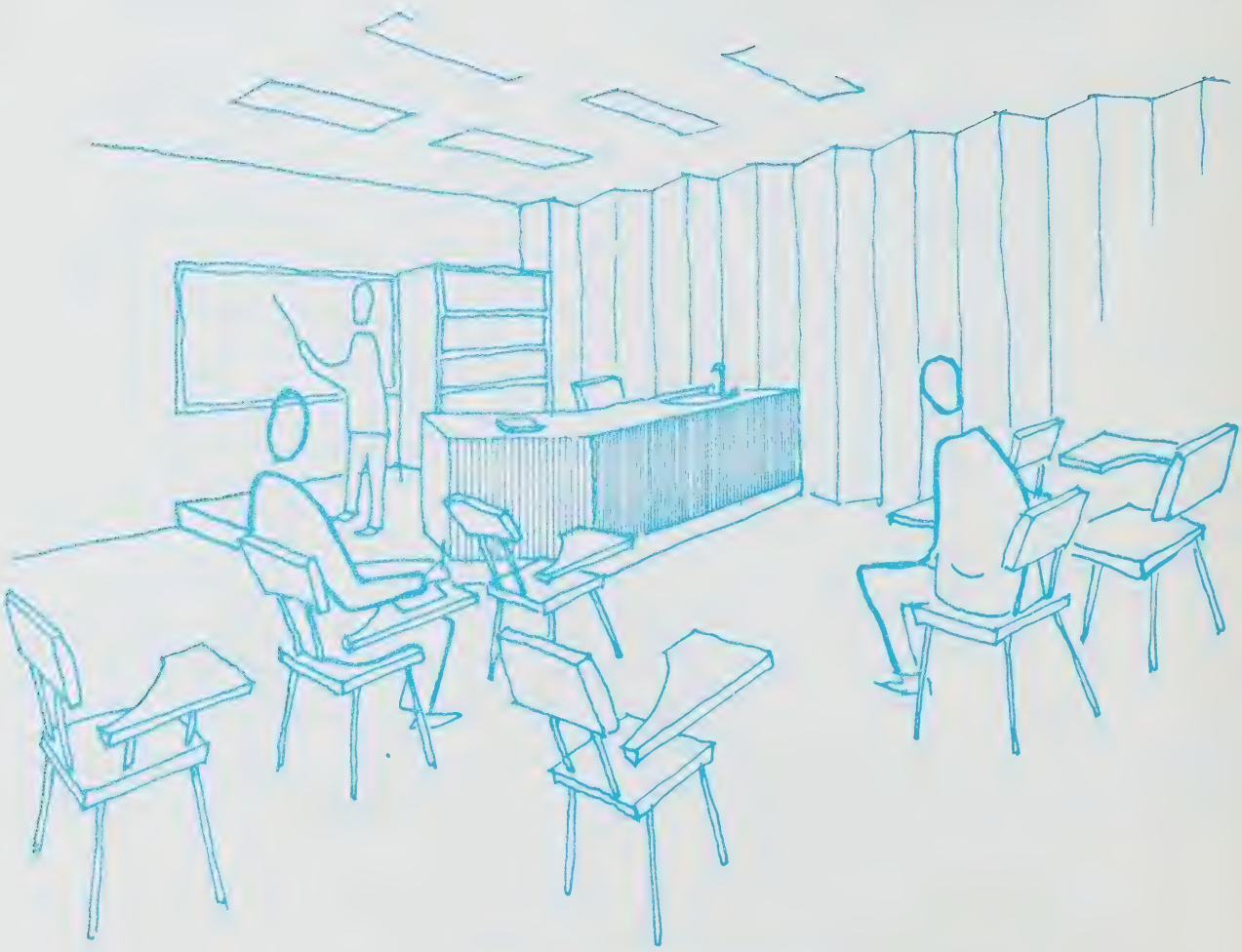
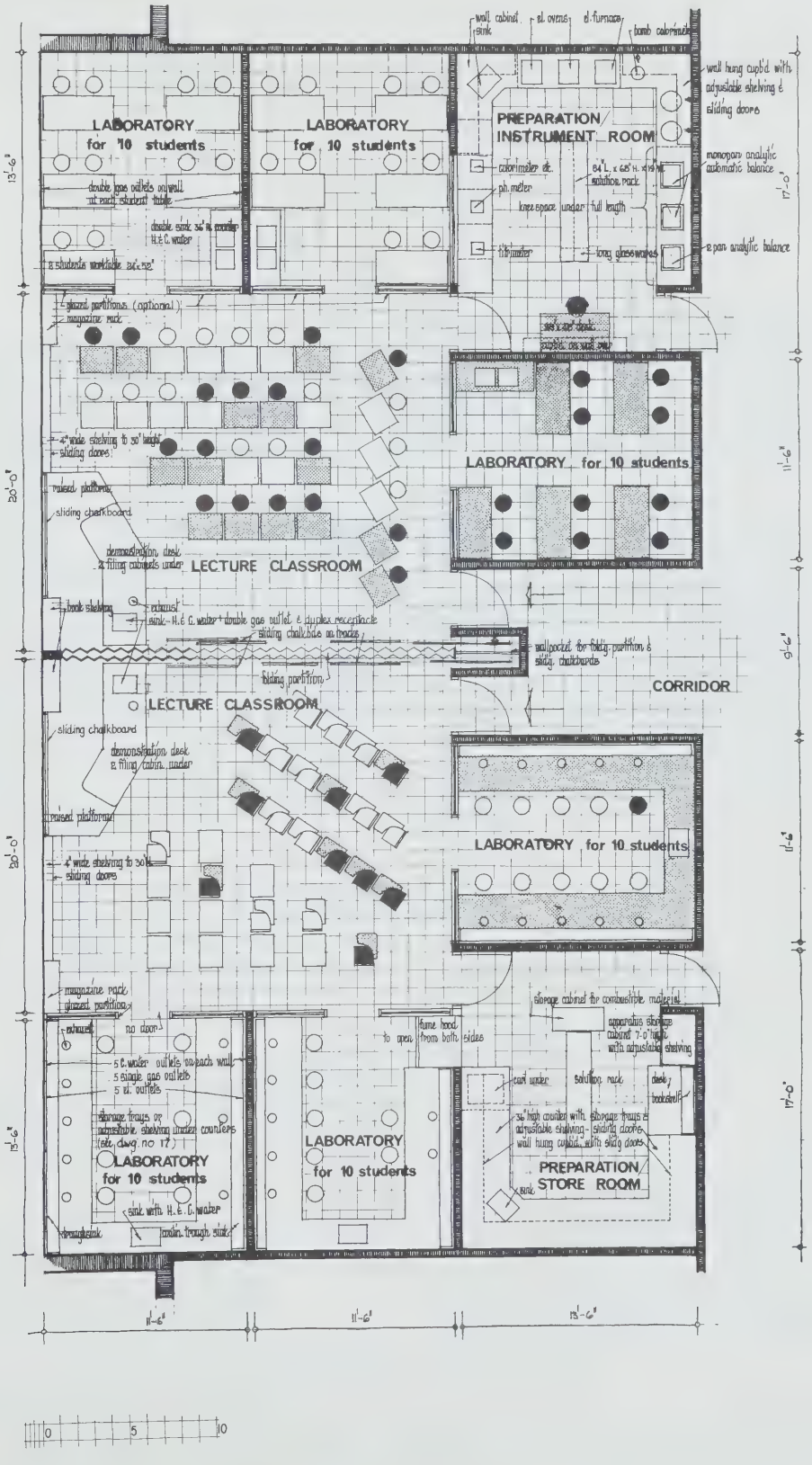
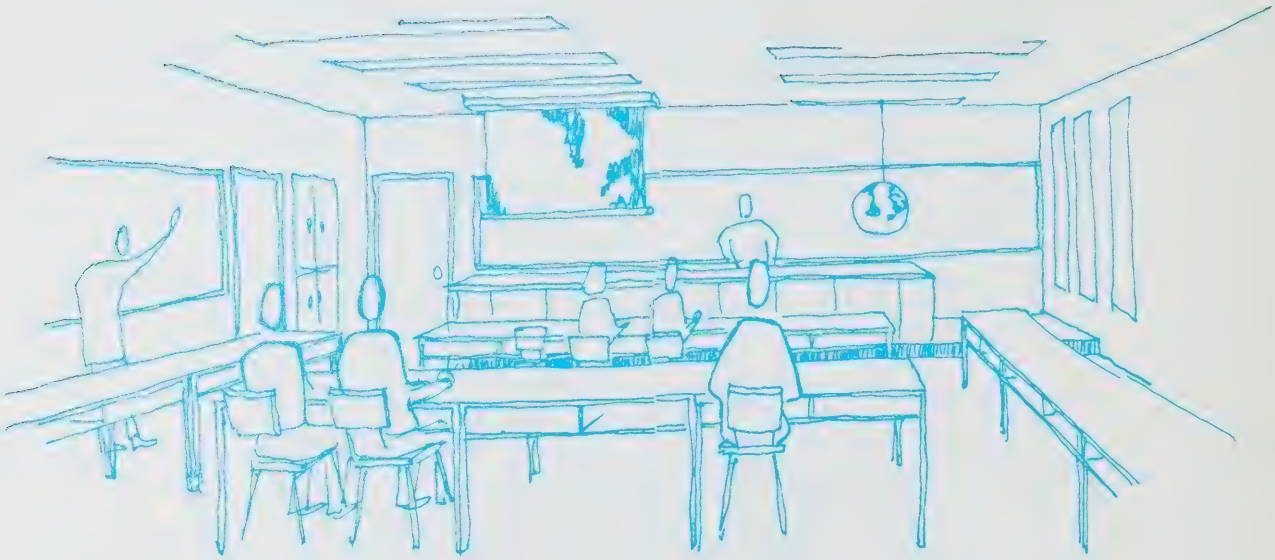


General Science Lecture Classroom

Floor Plan of General Science – lecture rooms, preparation and instrument rooms

Drawing 18





Geography Laboratory

Function

Geography is the bridge between the humanities and the sciences. Equipment required will include globes, wall maps, atlases, topographic maps, books and periodicals, slides, film strips, movies, aerial photographs and specimens.

Students do not sit passively at desks but will be engaged in drawing and construction of maps and diagrams, model making, observation and analysis of maps and photographs, study of specimens, individual research using a variety of material and viewing slides, filmstrips, etc. The geography room must therefore be designed to allow free movement around the teaching space. It must also be possible, with a minimal delay, to darken the room for the viewing of slides and films. There should be a preparation room adjacent, and preferably also a seminar room for group work meetings. The addition of a seminar room means that the geography area can be used in a variety of ways for various functions and activities.

Two geography laboratories with a preparation room and a seminar room between is convenient for schools of up to 1,000 pupils. Where there are 1,500 pupils and over, two such sets of facilities may be required.

Location

A southern orientation is desirable, and in a school of more than one storey, a location on the top floor. It is important for observation purposes that the room have a good view of the out-of-doors.

Facilities

For 30 students, a laboratory of 750 sq. ft. is sufficient. Where groups of students exceed 30, the floor area should of course be increased accordingly.

Furniture in the laboratory should include:

a) student tables, one for each two students, not less than 54 in. by 24 in. If single tables are preferred, each should be not less than 30 in. by 24 in. The height should be 31 in;

b) demonstration desk, a minimum of 12 ft. long by 2 ft. wide and 3 ft. high and with shelves for storing specimens, models, books and topographic maps. The top should be of laminated plastic;

c) fixed storage and work counter at rear wall, 24 in. wide and 32 in. high with plastic laminated top and arranged suitably for storage of materials. See Drawings Nos. 19 and 20.

Tackboard

An area of tackboard ample enough for displays is necessary. One wall should have tackboard from desk height to ceiling. A map of the local area should be permanently on view, as well as displays of current topics which may be changed from week to week.

Chalkboard

A large area of chalkboard is also essential for constant use for maps and diagrams.

Sliding chalkboards should be placed at the front of the room.

Fixed chalkboards are required on the side wall.

Maps

When maps are displayed it is important that they should not cover blackboards or tackboards. The detail in Drawing No. 19 therefore shows maps hung on spring-loaded rollers and mounted in recess in the ceiling. Smaller maps can be displayed in a variety of ways.

Globes

A number of different types of globes is necessary in the geography laboratory. Two most commonly used are the physical, political globe, 16 in. diameter and the chalkboard globe, 24 in. in diameter. These globes can be mounted on a roller stand, or in a cradle, or can be suspended from the ceiling at one side of the demonstration desk. Weights and pulleys allow them to be raised or lowered.

Projection Facilities

Screens can be placed either at the front or the rear of the room. Drawing No. 20 shows a screen mounted at

the front of the room and recessed so that it will not interfere with the chalkboard.

Electrical outlets will be required in positions to suit the equipment to be used. The use of a rheostat is also recommended.

Drawing No. 19 shows tackboard panels on hinges and sized to fill the window opening. When not used for this purpose they can be swung against the wall and used for display. Alternatively, special venetian blinds mounted in a frame can be installed.

Display Cabinets

For displaying geological specimens, a shallow wall cabinet with sliding glass doors is an advantage. The interior of the cabinet should be painted white to make specimens more visible.

The teacher's demonstration desk can also have built-in display cabinets facing the teaching area.

Preparation Room

The preparation room is a multi-functional area for the preparation of teaching materials and the planning of lessons by teachers. It may also be used as a seminar room and a study area.

Where there is a folding partition between the seminar room and the preparation room the combined area can be used as a large seminar room or small classroom.

It is emphasized that the preparation room is not primarily a storeroom although certain material and equipment will be stored in it.

Furniture and equipment will include:

a) a work table for the teacher. Details are shown in Drawing No. 19.

b) a work counter with open shelves and bookshelves above;

c) a storage cabinet with a sink and water supply;

d) a map storage cabinet with an illuminated drawing table on top;

e) a map rack mounted on one wall.

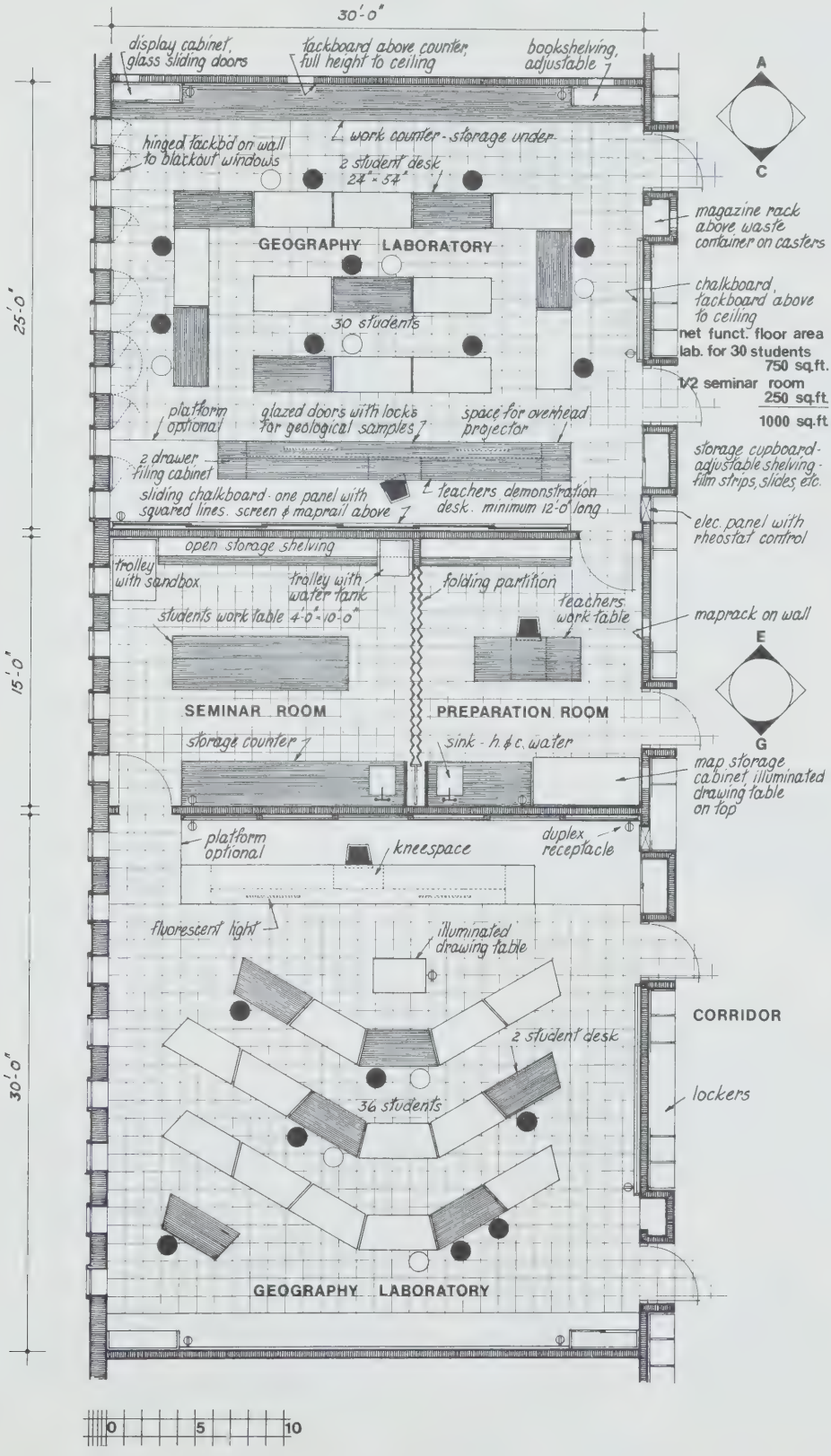
Filing cabinets may also be housed in the preparation room if space is available.

Seminar Room

The provision of a seminar room in the geography room, particularly if associated with the preparation room, will afford flexibility in the use of the other rooms, serve as a study and research area for groups of senior students and for project work. Some equipment and reference material may also be stored there, such as a sand box, 2 ft. by 4 ft. and 9 in. deep, preferably on a trolley. If the box is water-tight it can be used to illustrate river erosion, delta formation, etc. A water tank of glass to demonstrate wave forms, ocean currents, etc. and a steam table may also be stored there.

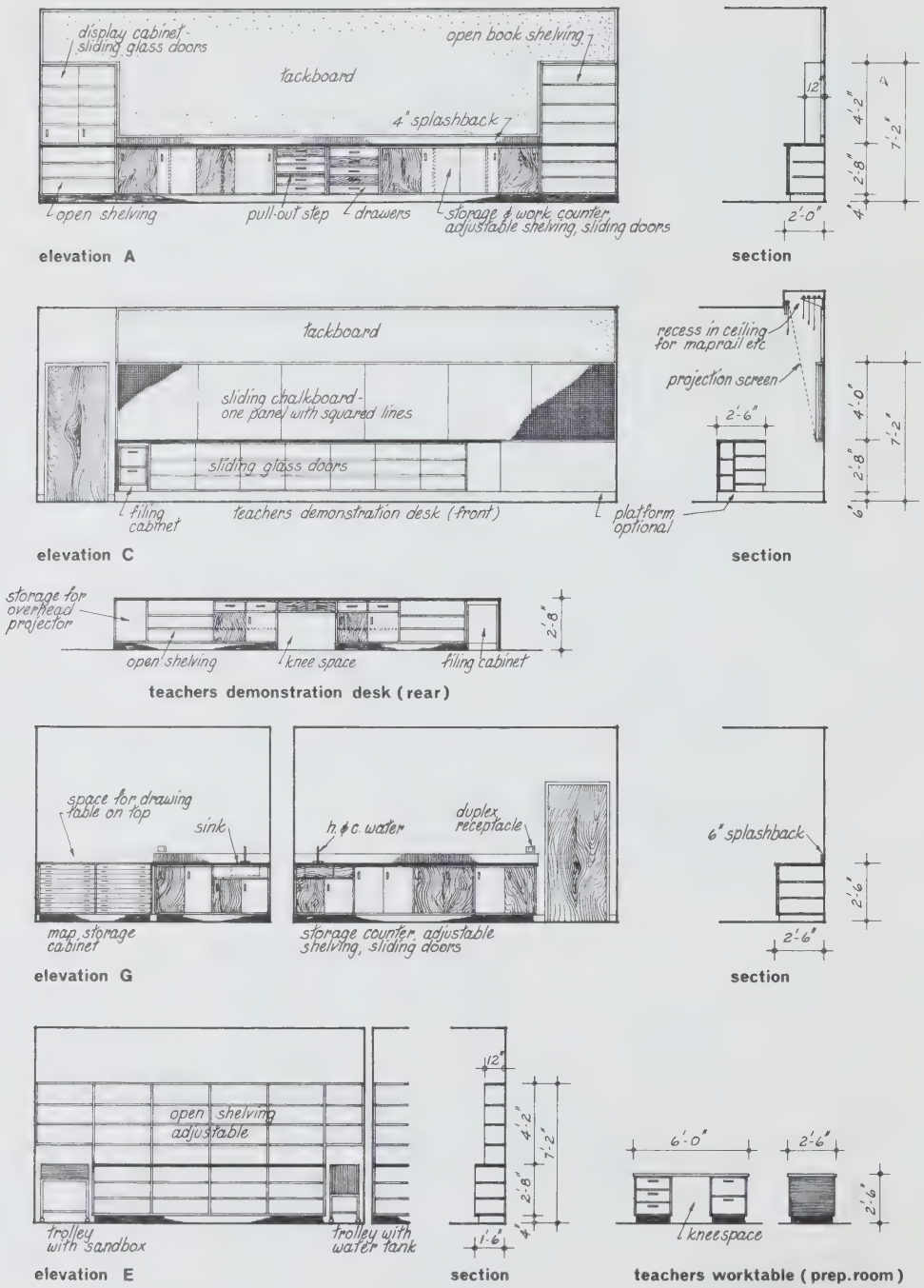
The storage unit and work top should also include a sink with hot and cold water supply.

Drawing 19


30'-0"
25'-0"
15'-0"
30'-0"
display cabinet, glass sliding doors
tackboard above counter, full height to ceiling
bookshelving, adjustable
work counter - storage under
hinged tackbd on wall to blackout windows
2 student desk 24" - 54"
GEOGRAPHY LABORATORY
30 students
magazine rack above waste container on casters
chalkboard, tackboard above to ceiling
net funct. floor area
lab. for 30 students 750 sq.ft.
1/2 seminar room 250 sq.ft.
1000 sq.ft
platform optional
glazed doors with locks for geological samples
space for overhead projector
2 drawer filing cabinet
storage cupboard - adjustable shelving - film strips, slides etc.
sliding chalkboard - one panel with squared lines, screen & maprail above
teachers demonstration desk, minimum 12'-0" long
elec. panel with rheostat control
open storage shelving
trolley with sandbox
trolley with water tank
folding partition
teachers work table
students work table 4'-0" - 10'-0"
maprack on wall
SEMINAR ROOM
PREPARATION ROOM
storage counter
sink - h. & c. water
map storage cabinet illuminated drawing table on top
platform optional
kneespace
duplex receptacle
fluorescent light
illuminated drawing table
CORRIDOR
2 student desk
lockers
36 students
GEOGRAPHY LABORATORY
A
C
E
G
0
5
10

Elevations, sections and alternate floor plans

Drawing 20



In considering the layouts for science laboratories the following points should be recognized.

1. Preparation rooms

Provision for accommodation in 'prep' rooms for the following is recommended so that maximum use of the laboratory for student activities may be arranged:

a) work areas for teachers to

–prepare materials and equipment for student participation;

–'try out' experiments (particularly important for inexperienced teachers and for new courses);

–repair and test equipment;

–do clerical work;

–prepare stock solutions;

b) storage of materials and equipment which should not be stored in laboratories, e.g. stock solutions, excessively hazardous materials, delicate instruments, flammable materials;

c) work areas for small groups of students to work at individual investigations or projects.

The general arrangements in the 'prep' room are not necessarily restricted to use with the type of laboratory shown. Any general arrangement may be chosen with facilities included which are indicated in the description above and in the drawings which follow.

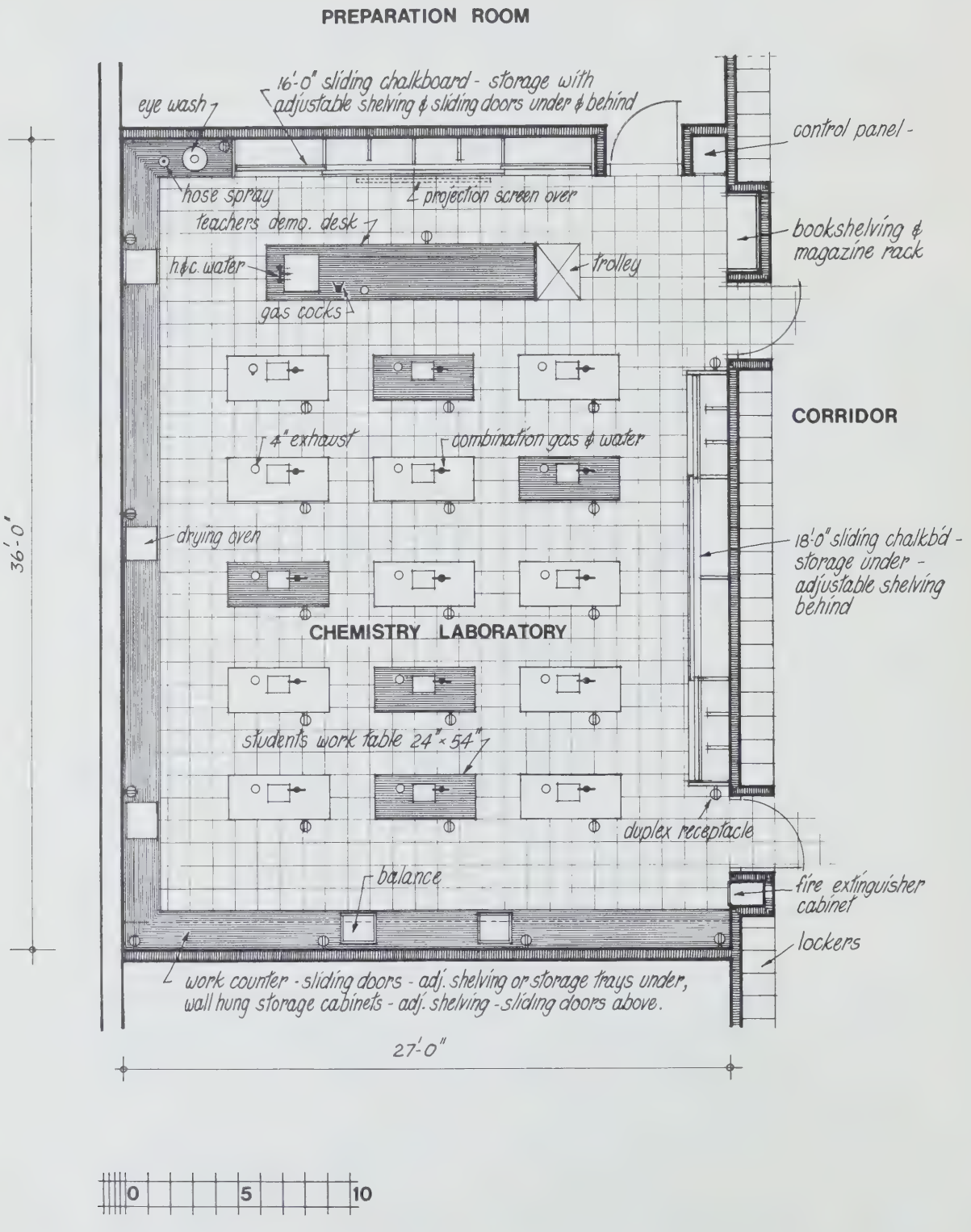
2. Laboratories

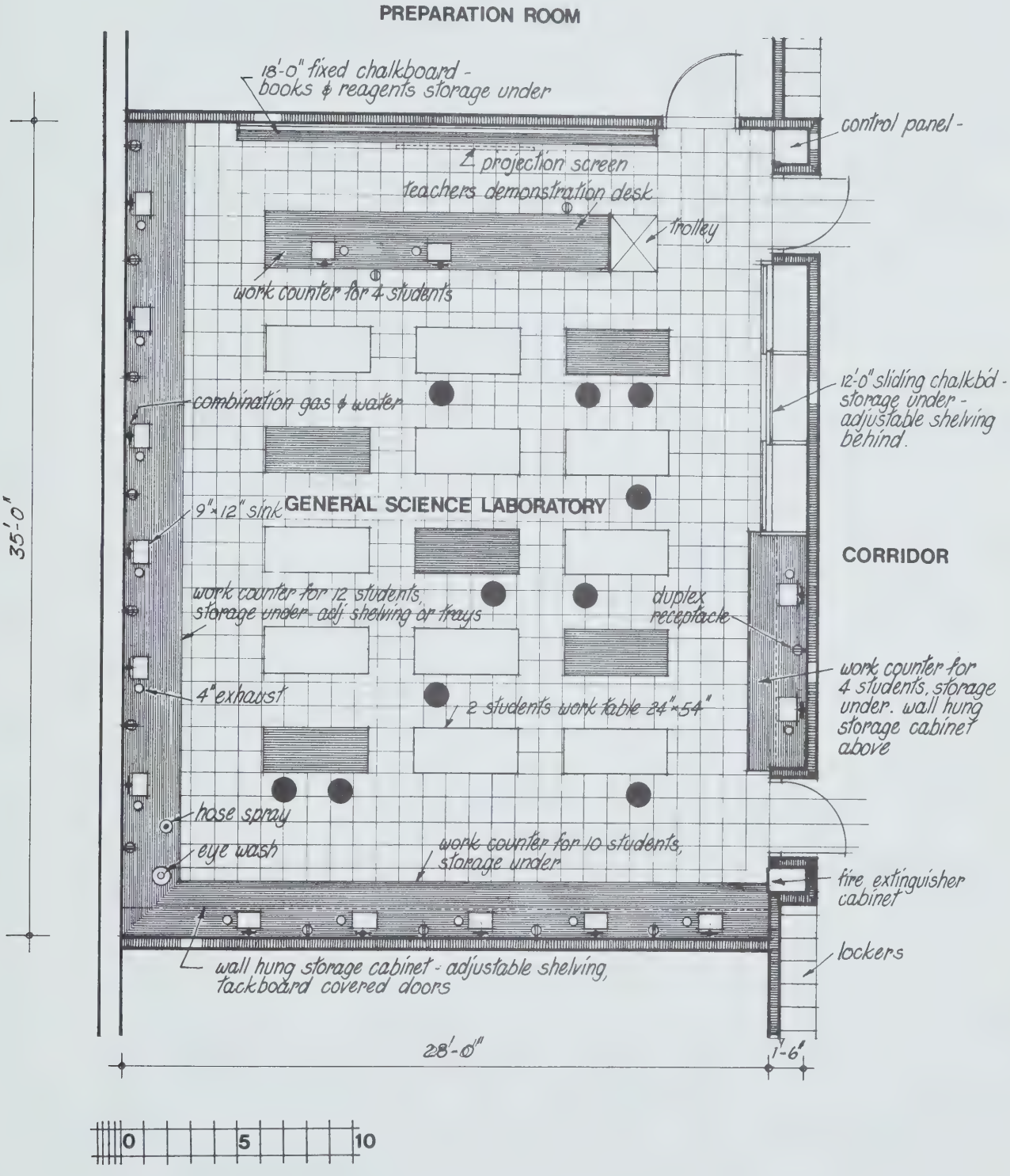
Laboratories smaller than 1,200 sq. ft. are approved for areas in stringent financial circumstances but are not recommended. The use of smaller laboratories imposes limitations on the development of effective science programs. Such small laboratories result in reduction of flexibility, quality of supervision of student activities, safety, attraction and retention of good science staff.

If small laboratories, c.f. Drawings 21 and 22, are being considered, it is advisable to consult with the School Planning and Building Research Section.

Chemistry Conventional Laboratory–floor plan

Drawing 21



General Science Perimeter Laboratory – floor plan

Drawing 22